APPLIED

Hydraulics & Pneumatics

PTEMBER 1958

SYSTEMS • COMPONENTS • SERVOS • ELECTRIC CONTROLS

Fluid Power for Missiles and Ground Support Equipment

see contents page 3

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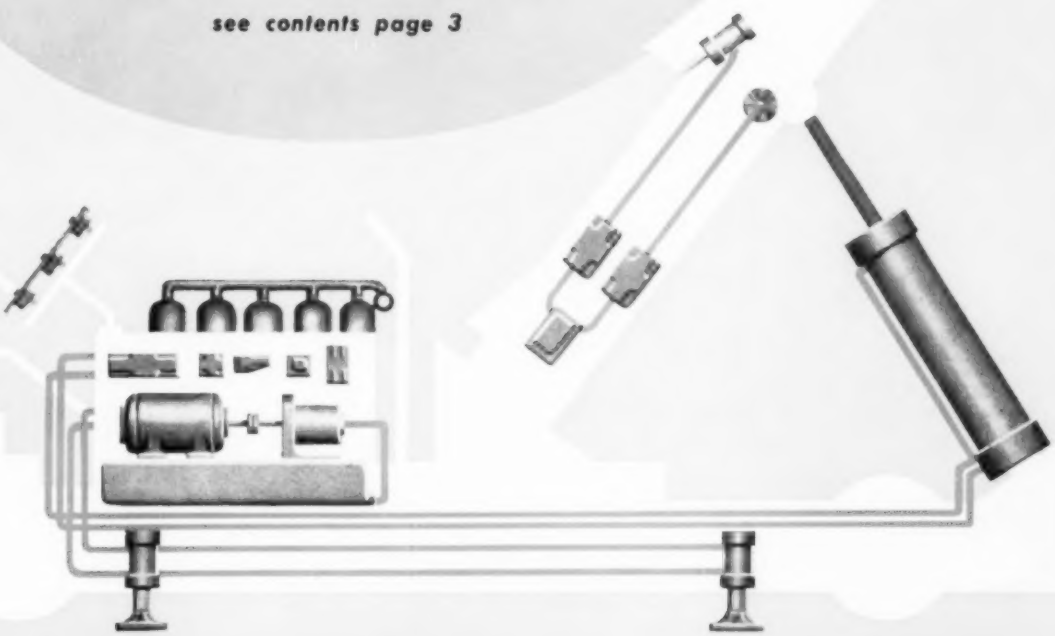

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AN INDUSTRIAL PUBLISHING CORPORATION MAGAZINE

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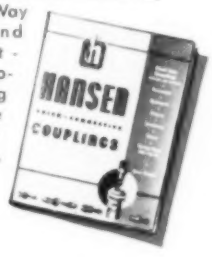

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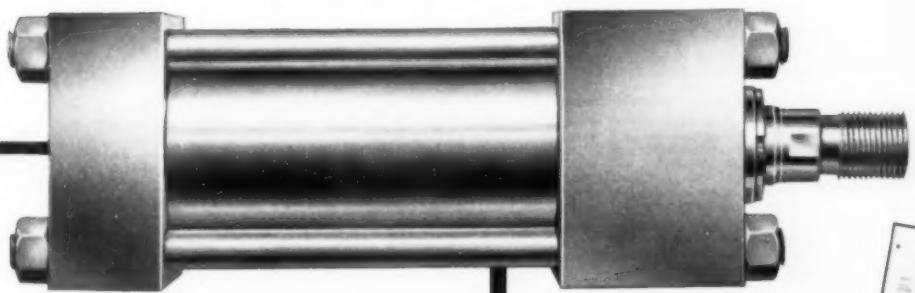
We will be happy to send you a catalog, and give you the name of your nearest Hanna Representative. You'll also find him listed in the yellow pages under "Cylinders" and in the alphabetical section of Thomas' Register.



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6. Finger-tip control and solenoid operated mechanisms.
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APPLIED
Hydraulics & Pneumatics

SEPTEMBER 1958 THE MAGAZINE OF FLUID POWER

VOLUME 11/NUMBER 9

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Editorial

We change our name

THE fellow who designs an air circuit to assemble TV tuners and the man who develops a hydraulic grinder are working with the same principles. They're pumping fluid (air or oil) through pipes, controlling it with valves, and making it do work by pushing cylinders, rotary actuators, or motors.

Since 1948, *as* APPLIED HYDRAULICS, *the magazine of fluid power, we've covered the design and application of equipment using a fluid to transmit energy to a working member. Becoming* APPLIED HYDRAULICS & PNEUMATICS *recognizes the wide use of compressed air along with present and future use of other gases to transmit energy. (There are articles on hot gas servos in this issue.)*

Our editorial concept remains the same: to emphasize design ideas using air and oil components. The application may be for precise control of a missile, or precise control of a machine tool slide. But because basic design problems—flow control, pressure regulation, synchronizing, etc.—are similar regardless of the job, the aircraft designer learns from an analysis of a grinder circuit . . . and the TV assembly machine.

To find applications with the most interesting designs, APPLIED HYDRAULICS & PNEUMATICS *editors travel throughout the country, visiting designers in every industry. From these discussions come the notes, drawings, photographs, sketches, and models that finally appear as articles. This first-hand reporting gives specialized reading with the design ideas highlighted so you can use them.*

In addition to application articles, our staff researches basic articles to give round-ups of what's available. The April issue on power sources and the August issue on designing for fluid maintenance are examples. Articles submitted by our readers often outline the procedure (and problems) in developing machines. On-the-spot reporting of technical meetings and exhibitors emphasizes new developments in pneumatics and hydraulics.

All of this adds up to a monthly package of design ideas called APPLIED HYDRAULICS & PNEUMATICS.

Paul Rolnick

EDITOR AND PUBLISHING DIRECTOR

APPLIED Hydraulics & Pneumatics

THE MAGAZINE OF FLUID POWER

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Useful Literature

CATALOG DESCRIBES ANCHOR REUSABLE COUPLINGS

Containing a wealth of specifications and informative engineering data, Anchor's Catalog No. 302 should prove extremely helpful to any designer or user of hydraulic equipment, or any other equipment that requires the transmission of fluid or gas under pressure.

In it, complete descriptions and specifications are given for the several styles of reusable couplings produced by Anchor and the various types of hose that can be used with the couplings to make up completed hose assemblies.

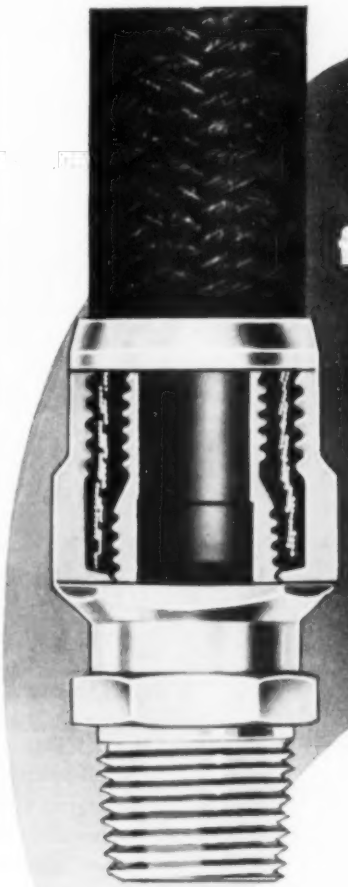
Prominent among the coupling styles shown in this catalog is the popular and widely used Duloc Reusable Coupling for medium and low pressure use with Anchor "QW" Hose. One of the outstanding features of this coupling is the speed and convenience with which it can be attached to the hose.

"QW" Hose is a one-cotton, one-wire and one-cotton braid hose; the outer cotton braid is impregnated with synthetic rubber. This hose is also available, as Style "QWR," with a thin rubber cover over the outer cotton braid serving as an abrasion resisting cover. Both styles are available from 3/16" to 1-13/16" ID, 3000 to 350 PSI Max. Working Pressure.

Other reusable couplings described in this new catalog are used for Style "C" high pressure 2-wire braid hydraulic hose, Style "F" medium and low pressure one-wire braid hydraulic hose, Style "HR" HI-BURST 2-rayon braid hose and Style "R" standard 2-rayon braid hose.

Specifications are also given for the complete line of Anchor Reusable Clamp-Type Couplings, available for high, medium and low pressure hose from ¼" to 2" ID.

Copies of this catalog are available upon request. Write to Anchor Coupling Co. Inc., 398 No. Fourth St., Libertyville, Ill., and ask for Anchor Catalog No. 302.



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MALE DULOC COUPLING available with NPTF, SAE and JIC Thread.

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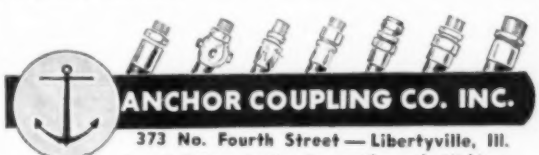
Wherever you have fluid being transmitted under pressure, you will find this time-tested, performance-proved team.

Anchor DULOC Reusable Couplings are economical — they can be used again and again without replacement parts. Anchor's Hex Drive Mandrel makes attachment quick and easy. Because of their compact, streamlined design they are easily connected, even in crowded, confined spaces.

Anchor Style "QW" is the perfect medium and low pressure hose for use with Anchor DULOC Couplings. With one-cotton and one-wire braid, and a synthetic impregnated outer cotton braid cover, it has ample bursting strength for medium pressure plus the abrasion resistance provided by the cover. Style "QWR" is similar in construction but has a thin rubber layer over the outer cotton cover for greater abrasion resistance.

Anchor DULOC Reusable Couplings and "QW" or "QWR" Hose are available in sizes from 3/16" to 1 13/16" inside hose diameters and recommended for 3000 to 350 PSI maximum working pressures, depending on size of hose.

See Us at the NCIH Sherman Hotel, Chicago October 16-17, 1958



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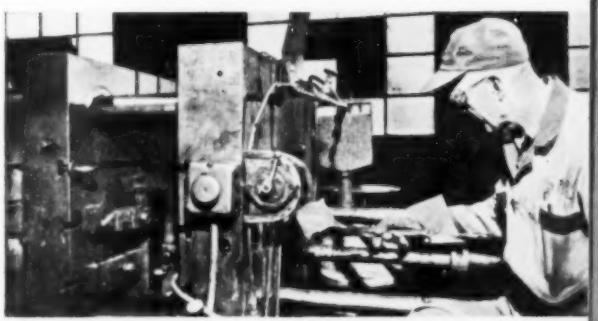

BETWEEN THIS . . .

Operator ladling molten metal into the shock chamber of 400-ton die casting machine. "Given the tremendous pressures under which the hydraulic fluid forces the ram home . . . we must prepare against a possible line rupture. It is vitally important that we use fire-resistant Cellulube in this operation."

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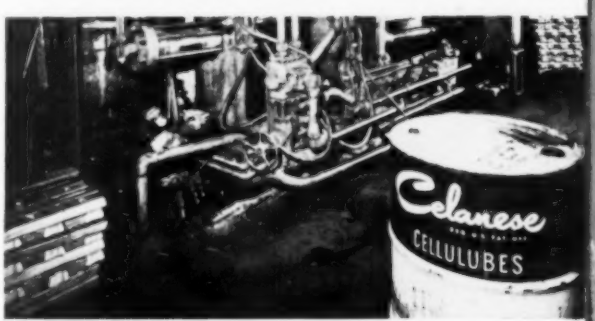

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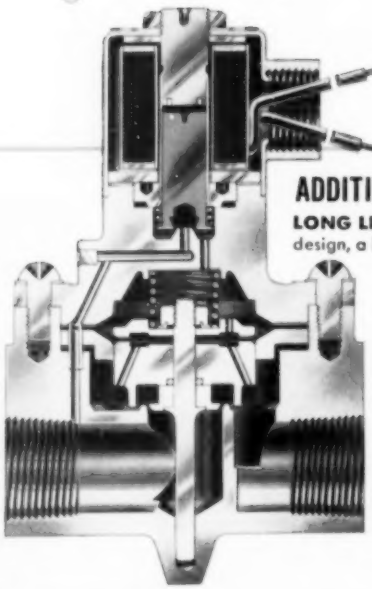

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These larger L Series models – ¾" and 1" – will be available in standard and Explosion-proof construction, normally open or normally closed. They operate on a pressure differential of 5 to 150 psi and will control such common media as air, oil and water.

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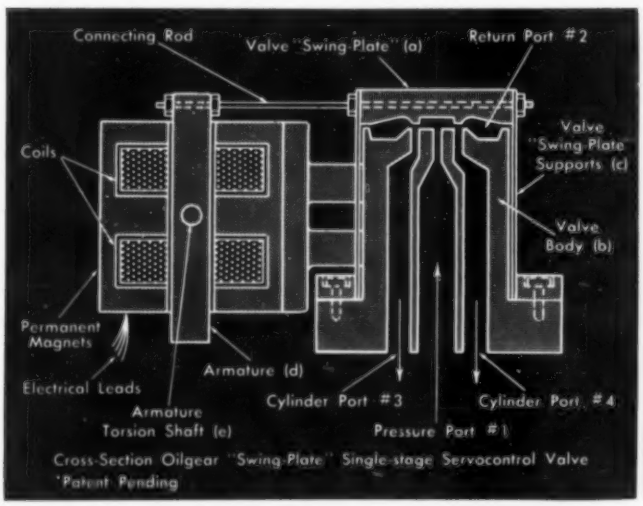
CIRCLE 123 ON TIME-SAVER CARD

. . . Fluid Power news

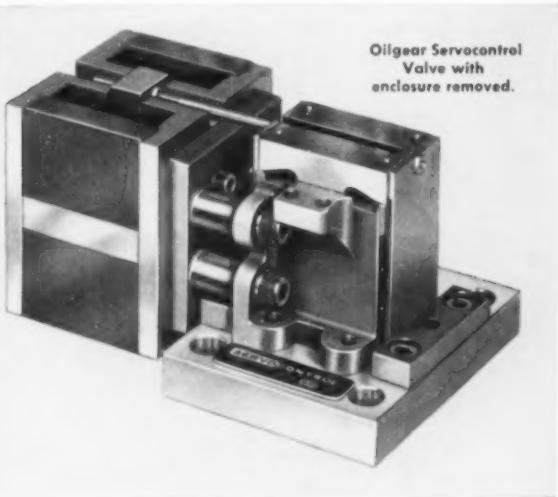
NEW INDUSTRIAL SERVO-CONTROL VALVES

New Oilgear Electrohydraulic Servocontrol Valves*

SERVO VALVE DESIGN OBJECTIVES: 1: Greater control accuracy and resolution for rotation and straight-line drives. 2. For industrial applications, must be capable of controlling wide pressure and volume range with single-stage, fast response to a low input signal. 3. Eliminate conventional valve frictional problems between spools and cylinders. 4. Eliminate two-stage linkage and stability problems. 5. Eliminate first-stage pilot systems — supply pressure, centering devices, filters, and orifices required for pilot systems. 6. Provide a flow rate substantially linear to valve displacement, with stability in null position. 7. Eliminate or substantially reduce valve "dead-band," sticking, jamming, scoring. 8. Be "fail-safe." 9. Operate safely in hazardous locations.



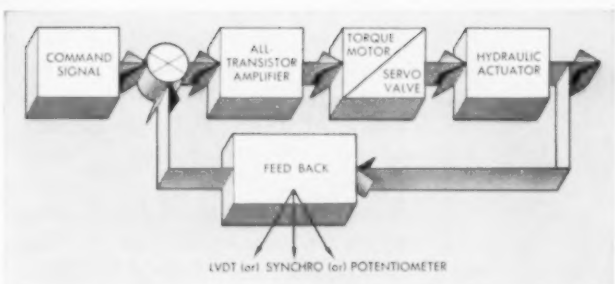
Cross-Section Oilgear "Swing-Plate" Single-stage Servocontrol Valve
*Patent Pending


Oilgear Servocontrol Valve with enclosure removed.

SOLUTION: 1. A new concept of three and four-way single-stage electrohydraulic servo valve construction . . . only two moving parts in Oilgear's new "Swing-Plate" design. 2. No metal-to-metal contact between "Swing-Plate" (a) and valve body (b) . . . frictionless for high sensitivity, fast response to minute signals — virtually eliminates sticking, scoring, jamming. 3. Clearances and port seal sizes can be varied to suit application and fluid handled. 4. Sharp, long rectangular chambers and lands linearize valve characteristics — flow rate essentially a linear function of valve displacement . . . supply high fluid power gain with minute "Swing-Plate" movement. 5. Hardened stainless steel construction assures reliable operation well in excess of a hundred million cycles, even with non-lubricating fluids. 6. No pilot system pressure, centering devices, orifices, or internal filters required. 7. Spring-steel supports (c) respond instantly to low torque motor forces. 8. As torque motor armature (d) pivots on torsion shaft (e), valve automatically centers in event of power failure for "fail-safe" operation. 9. For operation above 500 psi, a compensating cap equalizes hydraulic forces to maintain selected clearances. 10. No special modification required for use in hazardous locations. 11. Valves — open or enclosed — can be gasket-mounted. Pipe tap subplates are available.

PERFORMANCE DATA: Flow Rate — 4 gpm at 250 psi; 8 gpm at 1000 psi pressure drop across valve. Supply Pressures — to 3000 psi. Torque Motor; Mid Position Force — 11 lb min.; 5 watts max. power demand; Stroke — 0.015 inches; Hysteresis — less than 3%; Differential Current — 150 ma; Resistance per Coil — 80 ohms. Other coil current and resistance values available. Net Weight — 4¼ lb. Width: 4¾"; Height: 2¾"; Depth: 3".

Oilgear can supply all components for Fluid Power Servocontrol systems . . . all-transistor amplifiers, manual controls, preset controls, two-stage servo valves, variable displacement pumps, variable speed drives, motors and cylinders.



New Oilgear Servocontrol components applied to controls on Oilgear pumps and transmissions provide greater system accuracy and resolution. Functions easily attained with new Oilgear Servocontrol open and closed-loop systems are: 1. Precision, high-response speed control from zero to maximum rpm in either direction through remote control stations or switches. 2. Positive, high response, follow-up position control through remote command units. 3. Output motions or speeds with closed-loop systems will remain near constant with accuracies from 0.1% to 1.5%, and with resolution down to 0.05%.

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FLUID POWER LINES

about applied hydraulics

BEHIND SCENES . . . It was a cheerful Monday morning early in February when the editor's intercom buzzed and the voice of the head man asked, "Got any articles in the works on fluid power for a missile program?"

"A couple."

"Get more and put together an entire issue."

So here's the issue. It's an easy business we're in. All it takes is a simple request followed by six months of hard work by three editors, the cooperation of 43 companies and the Defense Department, and 11 authors. It took 23 days of travel, 262 letters, and 126 minutes of long distance phone calls.

The result is the most complete coverage ever presented on the design and application of fluid power systems for the missile and ground support program.

Our work developed more articles than could be included in any one issue. These will of course be published in coming months to keep you abreast of design ideas for this growing field.

HOT TOPIC . . . for real, is the hot-gas servo system. One of the latest fluid power developments, it may be an answer to high-temperatures encountered in missiles. At least temperature variations shouldn't cause trouble when you work at a nice, constant 3000 F. The article on page 98 tells what the hot-gas servo can do, when to consider using one, and gives the diagram for one that will work.

A REAL GASSER . . . pushes the juice out of the bottle, through the pipe, and into the thing that twists the tail, to steer the bird. Translation: Hot gas pressurizes an accumulator to supply hydraulic fluid to the cylinders that move the flight control surfaces on the Sparrow I missile. This small, light system does a dandy job with a minimum of muss and fuss where operating time is short. Read all about it on page 95.

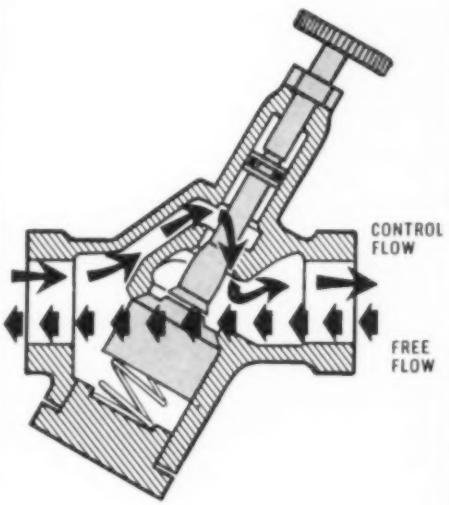
DOG THROWER? . . . No, indeed! Just in case you saw a title on the contents page that made you think that by turning to page 108 you could read all about a hydraulic widget for heaving our canine friends through the air, you can't. The Terrier launcher is used to get a guided missile called the Terrier into the air. (SPCA, please note.) Incidentally, quite a few missile names may remind you of some furred or feathered friend. These are: Bullpup, Bull Goose, (Is that what they used to call a gander, Dad?), Dove, Falcon, Diamondback (a rattlesnake), Hawk, Hound Dog, Green Quail, Petrel, Rat (This is a furred friend?), Sparrow, Terrier, and Wagtail (Webster says the wagtail is any of numerous mostly Old World birds allied to the Pipits.)

STAIRWAY TO THE STARS . . . may be bending the old poetic license (or something) a little bit but it came to mind while we worked on the story of the Arcon research rocket launcher. This launcher, fluid-power operated of course, is a direct descendent of the device used to position one of those ladders that firemen climb to rescue the girl from the burning building. Get the connection? Well-l-l, anyhow, there's a factual description on page 102.

Tranquilize your cylinders

Rx

Ross speed control valves

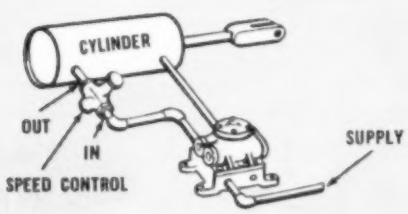


FREE FLOW TO CYLINDER (LEFT)
CONTROLLED FLOW FROM CYLINDER

PRICED WITH THE LOWEST

By keeping full power driving the cylinder but metering the flow from it, you can get smooth, positive and infinitely variable control of the cylinder speed without the problems that come with trying to adjust cylinder movement by varying inlet pressure. This is why speed control valves are so satisfactory for making cylinders act right. And why do so many specify Ross speed controls?

Simply this. When you turn the adjustment screw things don't "just happen." Instead, you force the air to flow through a carefully engineered variable orifice, an orifice designed to create fine shadings of control at both high and low flow rates. And, this performance is yours in a valve that is designed and built to thrive under rough conditions and still be around for a long time. This valve's only moving internal part is its poppet. You can lock its adjustment against tampering. It mounts in any position. Its aluminum alloy body gives heavyweight performance with welterweight bulk. Join the thousands who profit by using Ross speed control valves.



The speed control valve as used between a 4 way valve and a cylinder, shown above, regulates (slows down) the piston rod retraction.

FULL RANGE IN STOCK

3 ADJUSTABLE HEAD STYLES AVAILABLE, KNOB, PIN OR SLOT

ALUMINUM ALLOY BODY

BUBBLE TIGHT POPPET

PIPE SIZE ¼, ⅜, ½, ¾, 1, 1¼

Call your nearby Ross Valve engineer or write us.

Ross OPERATING VALVE CO. 105 East Golden Gate • Detroit 3, Michigan

CIRCLE 117 ON TIME-SAVER CARD

GREER designs and builds the most efficient and dependable HYDRAULIC SYSTEMS for your missile launcher!

GREER PROVIDES A COMPLETE POWER PACKAGE AT LOW COST!

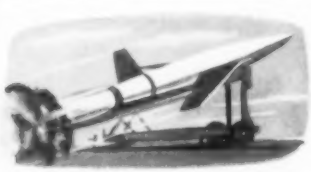
Greer's enviable reputation for the creation of hydraulic systems began more than 15 years ago. Greer has designed, developed and built hundreds of hydraulic systems for leading aircraft and equipment manufacturers. You'll find Greer systems on planes, ships, missiles, submarines, buses, machinery – and on almost any hydraulic equipment you can name.

Greer's important contribution in the guided missile field includes major work on the Bomarc, Redstone, Talos, Terrier and Thor. Greer has provided systems and components for these operational and experimental missiles since the inception of the program.

Greer's staff of engineers is ready to put this hard-to-find experience and know-how to work for you. Greer now offers you on-time delivery of a complete hydraulic system for your missile launcher... probably at what it would cost you to design the system alone. Contact us now for immediate action.

GREER GROUND SUPPORT EQUIPMENT

MISSILE GO NO-GO SYSTEMS



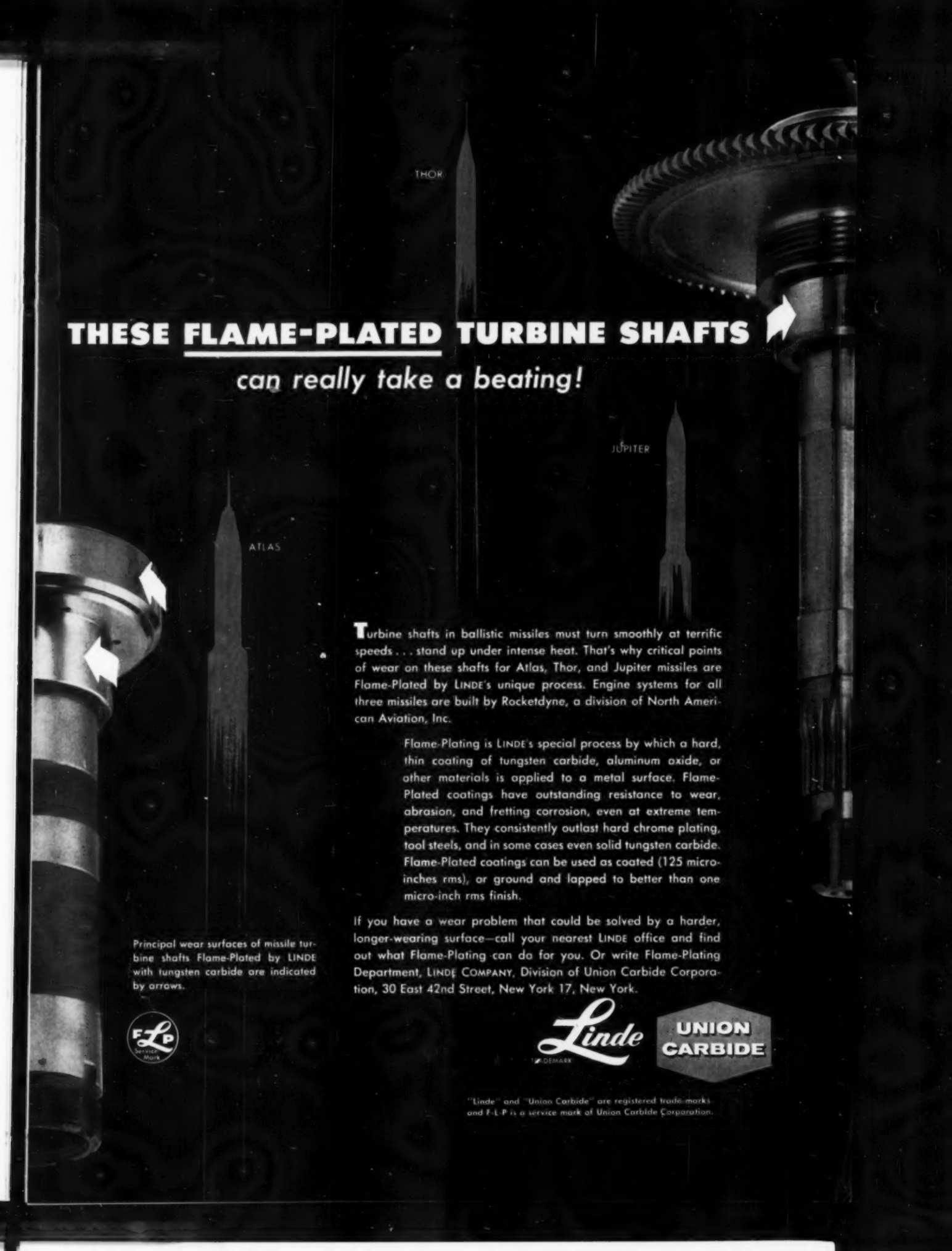
MISSILE LAUNCHING SYSTEMS

MISSILE GAS BOOSTER SYSTEMS

GREER HYDRAULICS, INC. • NEW YORK INTERNATIONAL AIRPORT • JAMAICA 30, NEW YORK

CIRCLE 57 ON TIME-SAVER CARD

CIRCLE 82 →



THESE FLAME-PLATED TURBINE SHAFTS

can really take a beating!

Turbine shafts in ballistic missiles must turn smoothly at terrific speeds . . . stand up under intense heat. That's why critical points of wear on these shafts for Atlas, Thor, and Jupiter missiles are Flame-Plated by LINDE's unique process. Engine systems for all three missiles are built by Rocketdyne, a division of North American Aviation, Inc.

Flame-Plating is LINDE's special process by which a hard, thin coating of tungsten carbide, aluminum oxide, or other materials is applied to a metal surface. Flame-Plated coatings have outstanding resistance to wear, abrasion, and fretting corrosion, even at extreme temperatures. They consistently outlast hard chrome plating, tool steels, and in some cases even solid tungsten carbide. Flame-Plated coatings can be used as coated (125 micro-inches rms), or ground and lapped to better than one micro-inch rms finish.

If you have a wear problem that could be solved by a harder, longer-wearing surface—call your nearest LINDE office and find out what Flame-Plating can do for you. Or write Flame-Plating Department, LINDE COMPANY, Division of Union Carbide Corporation, 30 East 42nd Street, New York 17, New York.

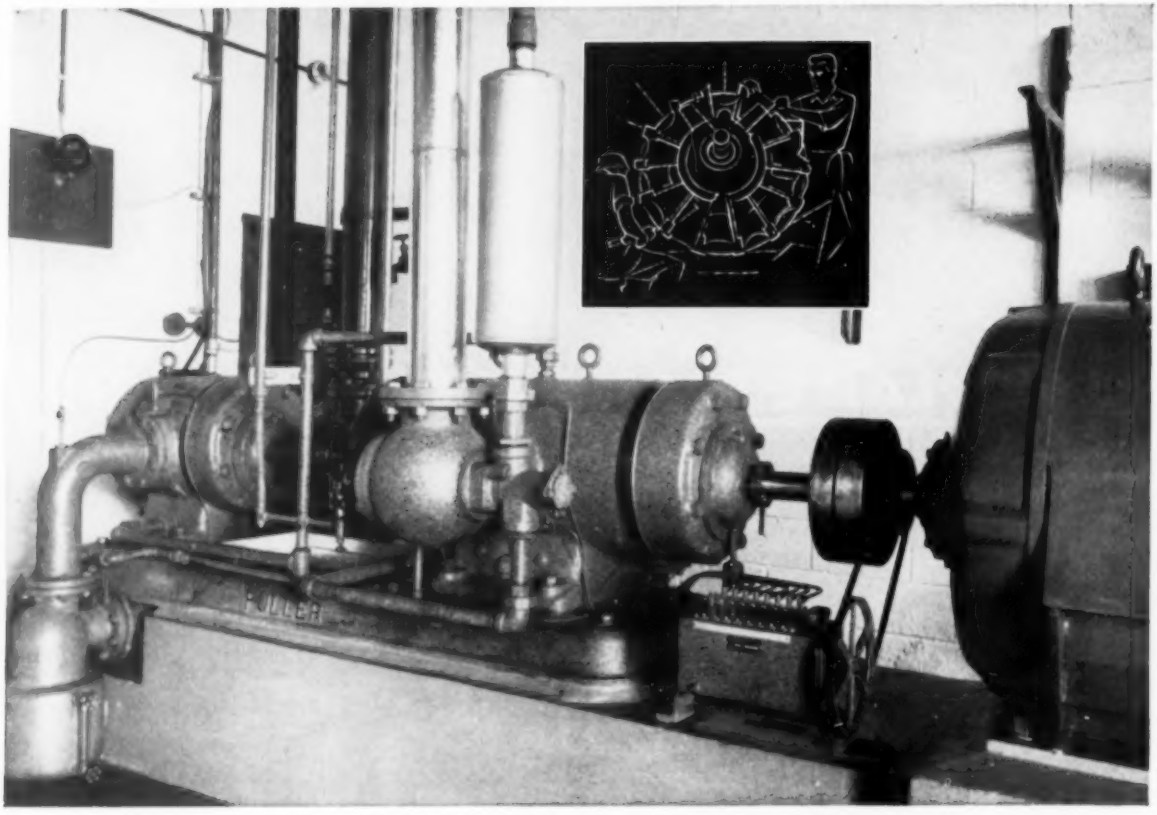
Principal wear surfaces of missile turbine shafts Flame-Plated by LINDE with tungsten carbide are indicated by arrows.

F-L-P Service Mark

Linde TRADEMARK

UNION CARBIDE

"Linde" and "Union Carbide" are registered trade-marks and F-L-P is a service mark of Union Carbide Corporation.



WHY DID AIRWORK SPECIFY A FULLER AIR COMPRESSOR?

Here's what the Vice President-Operations of Airwork Corporation, one of the nation's leading aircraft overhaul companies, writes about Fuller Model C-150-150H Rotary Air Compressors.

"We were running out of air capacity, and had decided that we would like to get rid of the maintenance problems inherent in a piston type air compressor.

"The Fuller compressor with its fewer moving parts and favorable price range met our basic requirements.

"We then checked on Fuller compressor performance through our close contacts with a leading manufacturer of aircraft engines. Their opinion was very favorable. We think Airwork has made the right decision."

Here are the features that sold Airwork on a Fuller Compressor:

- Wide seal between rotor and bottom of cylinder, assuring high volumetric efficiency.
- Rotary design assuring vibration-free flow of air.
- Direct drive.
- Compact space-saving installation.
- Simple foundation.
- No valves to leak or seats to grind.
- Few moving parts, keeping maintenance time to minimum.
- Designed for continuous duty service

When your plant needs reliable air power, call on Fuller. To get all the facts on Fuller Rotary Compressors for capacities up to 3300 C.F.M. and pressure to 125 pounds, write today,

Fuller

FULLER COMPANY GENERAL AMERICAN

FULLER COMPANY C-323 4914

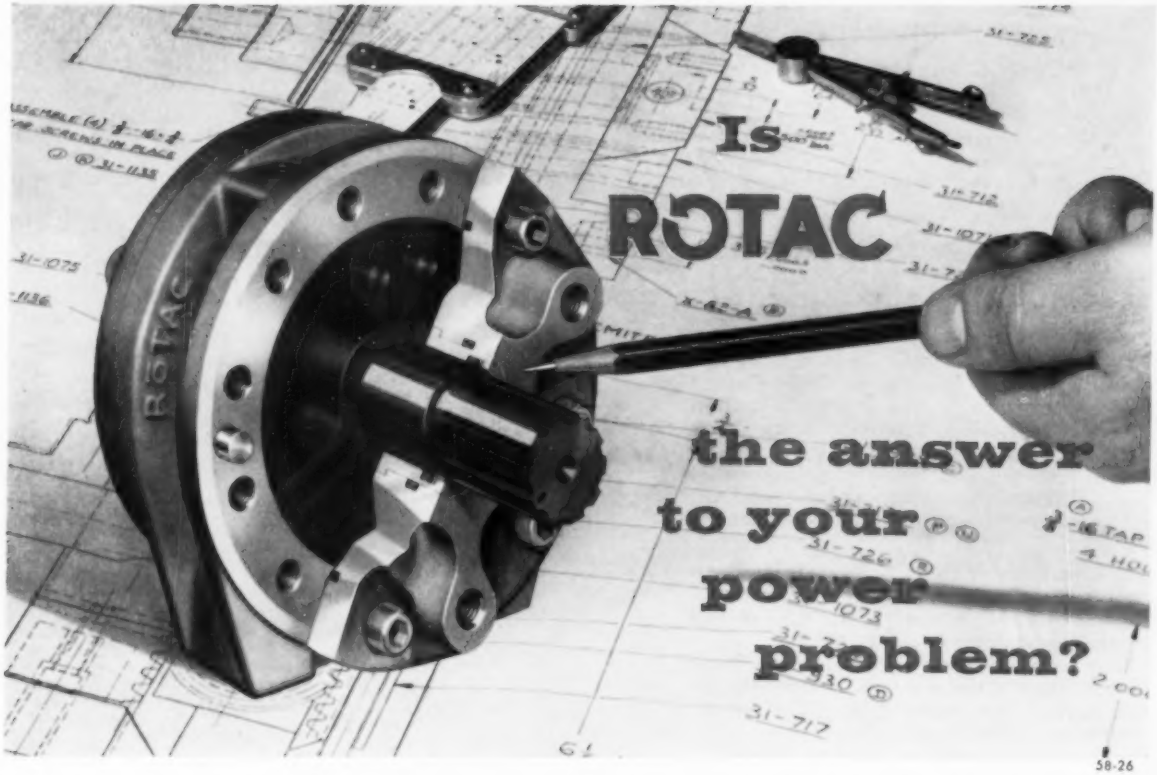
142 Bridge St., Catasauqua, Pa.

SUBSIDIARY OF GENERAL AMERICAN TRANSPORTATION CORPORATION

Birmingham • Chicago • Kansas City • Los Angeles • San Francisco • Seattle

PIONEERS OF HIGH-EFFICIENCY VANE TYPE ROTARY COMPRESSORS SINCE 1930

CIRCLE 53 ON TIME-SAVER CARD



Rōtac torque actuators are simple, compact—provide positively controlled power for any movement from turning watch parts to tipping railroad cars

RŌTAC Rotary Torque Actuators consist of a cylindrical chamber containing a stationary barrier or shoe, and a central shaft with a fixed vane. With fluid or pneumatic pressure applied to either side of the vane, rotary movement in the opposite direction is obtained.

There is no complex linkage, no plunger action: RŌTAC's few moving parts are completely sealed from dirt and natural elements. Patented O-rings are used around vane, shoe and end caps.

RŌTAC Torque Actuators can be mounted easily—vertically, horizontally or at any angle—with the housing held stationary, or with the body rotating around the shaft.

To simplify design problems, for versatility in extended applications, specify RŌTAC Actuators for powerful, easily controlled rotary motion in compact form.

FREE DESIGN DATA BOOK—20 PAGES

Contains everything you'll want to know about RŌTAC — Installation details • Dimensions • Torque ratings • Helpful ideas for using RŌTAC Actuators in your operations.

EX-CELL-O CORPORATION

GREENVILLE PLANT, GREENVILLE, OHIO

EX-CELL-O PRECISION PRODUCTS INCLUDE: MACHINE TOOLS • GRINDING AND BORING SPINDLES • CUTTING TOOLS • RAILROAD PINS AND BUSHINGS • DRILL JIG BUSHINGS • AIRCRAFT AND MISCELLANEOUS PRODUCTION PARTS • TORQUE ACTUATORS • DAIRY EQUIPMENT

Just 4 of the hundreds of recent applications

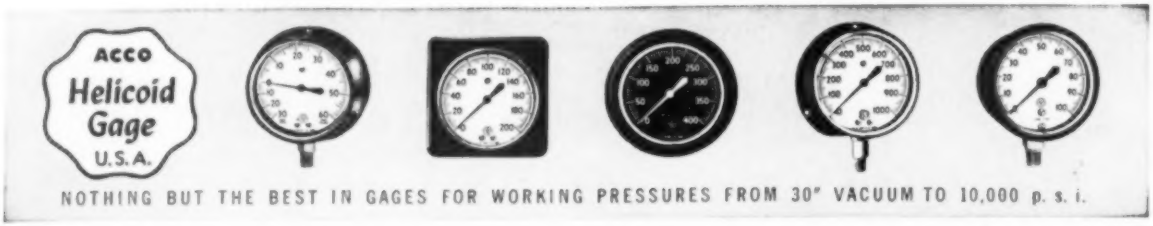
1. MOBILE EQUIPMENT—A compact RŌTAC Actuator swings truck crane boom in 280° travel arc; it's controlled by a 4-way valve.

2. MACHINE TOOLS—Automation machine for boring, grooving piston wrist pin holes uses RŌTAC Actuator to orient arbors for hole alignment.

3. FOUNDRY MACHINERY—RŌTAC Actuators supply motive power for turnover of the core-box on semi-automatic shell core blower.

4. PAPER MACHINERY—Collector roll is actuated by a Model HN-63-1V RŌTAC Actuator which unloads material after slitting operation.

XLO EX-CELL-O FOR PRECISION



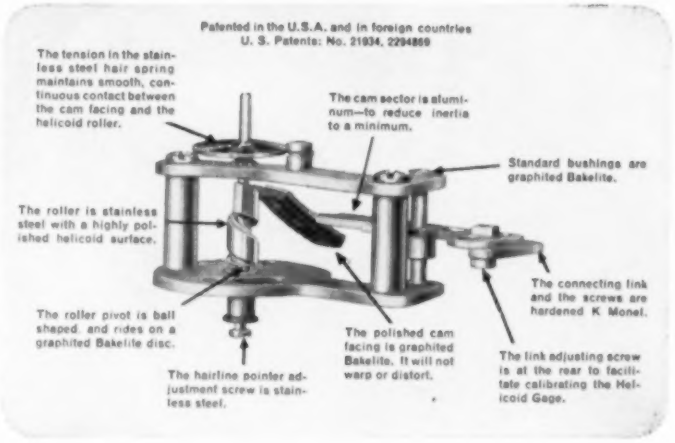
Shock-Proof Cam Actuation (no gears—no teeth) Makes Helicoid Gages Ideal for Hydraulic Services

Designed for pulsating and impact hydraulic service, the Helicoid movement releases at zero in the event of sudden pressure reduction. This eliminates shock on pointer and movement by reducing impact of pointer against pointer stop pin. This protects the gage mechanism where gages may be subject to occasional vacuum.

The superiority of Helicoid Gages is most evident in severe service—wherever a gage is subjected to violent pressure pulsations or certain severe mechanical vibrations.

The *sustained accuracy* of Helicoid Gages over *millions of cycles* is explained by the details of design and construction of the Helicoid movement shown at the right.

Rolling action of the cam facing against the roller surface . . . graphited Bakelite bushings, roller pivot base and cam facing . . . K Monel connecting links and screws . . . all such Helicoid features protect against wear and corrosion and assure sensitivity, sustained accuracy and trouble-free operation through millions of cycles.


Patented in the U.S.A. and in foreign countries
U. S. Patents: No. 21934, 2294859
The tension in the stainless steel hair spring maintains smooth, continuous contact between the cam facing and the helicoid roller.
The cam sector is aluminum—to reduce inertia to a minimum.
Standard bushings are graphited Bakelite.
The roller is stainless steel with a highly polished helicoid surface.
The connecting link and the screws are hardened K Monel.
The roller pivot is ball shaped, and rides on a graphited Bakelite disc.
The polished cam facing is graphited Bakelite. It will not warp or distort.
The link adjusting screw is at the rear to facilitate calibrating the Helicoid Gage.
The hairline pointer adjustment screw is stainless steel.

HELICOID GAGE CARTRIDGE SNUBBER

(Patent pending)

This is a simple, effective throttling device to reduce or eliminate pulsations of the gage pointer. There are no moving parts, no adjustments needed. Available in three types in powdered bronze or stainless steel for air, gas, water, steam, medium or heavy liquids.

Enlarged cutaway view

Threaded cartridge body for assembly in any Helicoid Gage tapped socket shank

EASIEST ADJUSTMENT AND CALIBRATION

Only Helicoid Gages have the external pointer adjustment pictured here. The Helicoid type adjustment cannot be jarred out of position.

Calibration of Helicoid Gages is accomplished easily, without removing dial or pointer, because the link adjusting screw is at the rear of the system.

TUBES BUILT FOR MILLIONS OF PRESSURE PULSATIONS

To fit the wide range of applications, Helicoid Bourdon tubes are available in four materials—alloy steel, K Monel, stainless steel and phosphor bronze.

All Helicoid tubes are made from seamless tubing and are carefully designed to give maximum torque and minimum stress. When used within the dial range, they will withstand many millions of pressure pulsations and will not stretch, leak nor crack.

DOUBLE SCALE DIAL SHOWS TONS ON RAM AND PSI

Helicoid Gage dials are supplied in jet black with white figure markings or in dull white with black figure markings. They are constructed of laminated phenol with a transparent plastic surface and the longest possible scale length for more accurate readings. They are non-corroding, will not discolor nor fade and will not crack, chip nor peel.

Helicoid Gage Division
AMERICAN CHAIN & CABLE

929-H Connecticut Avenue • Bridgeport 2, Connecticut

ACCO

TRADE MARK

Helicoid gives you all these features at prices that are competitive in the quality gage field

RACINE-SECO HYDRAULIC PUMPS

LOW PRESSURE—HIGH VOLUME

offer maximum performance and adaptability

HIGH PRESSURE—LOW VOLUME
Model LA Radial Piston Pump ½ to 20 gpm—up to 10,000 psi.

Tailored to fit the job . . . One source—one responsibility

FEATURES

VANE TYPE PUMPS

- ★ 5 to 70 gpm—up to 1000 psi
- ★ Variable volume for reduced horsepower consumption
- ★ Maintain pressure without costly waste of by-passing oil
- ★ Variety of governors available to suit your requirements

RADIAL PISTON PUMPS

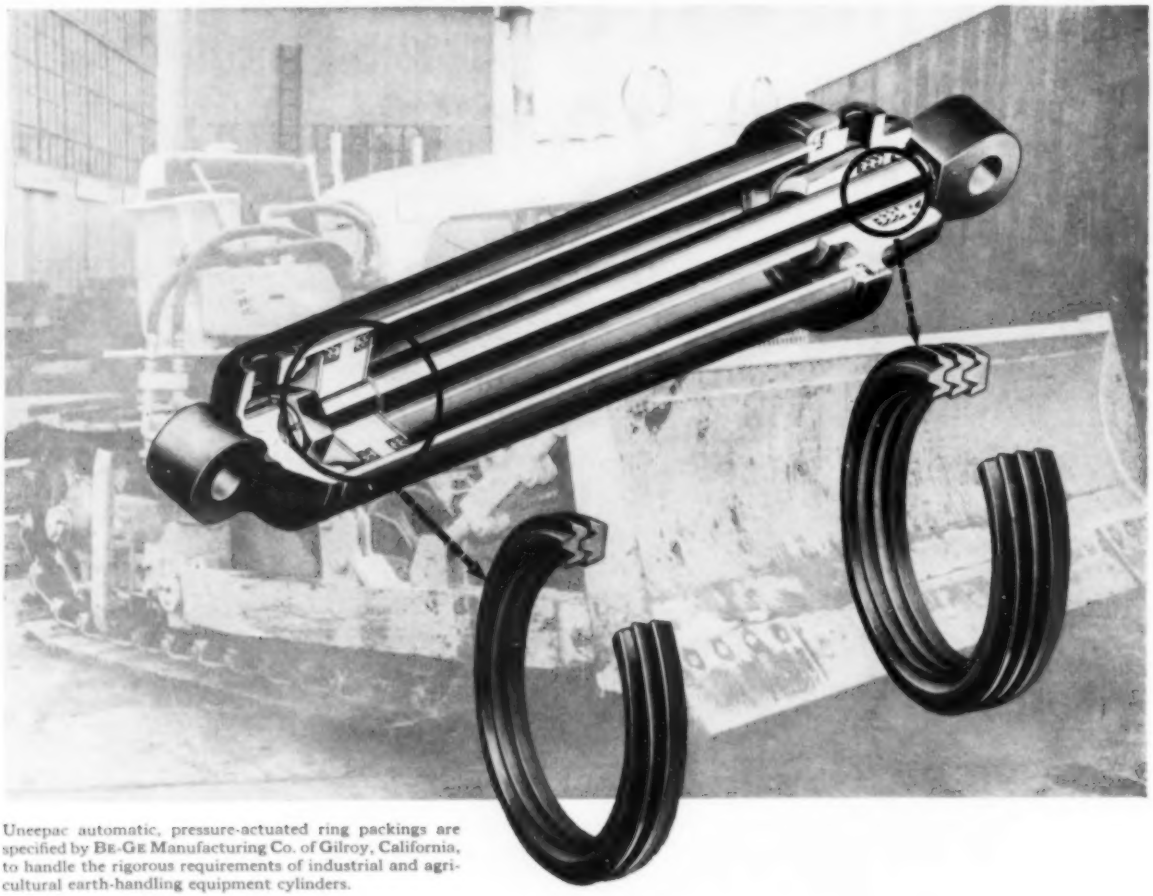
- ★ ½ to 20 gpm—up to 10,000 psi
- ★ ISO-FLO design for several isolated flows from *one* pump
- ★ Isolated flows at one pressure or several pressures
- ★ Ideal for accumulator circuits and parallel feed of cylinders

Utilize our FREE Engineering Service for the most efficient and economical circuit. Write or call for complete descriptive data on RACINE-SECO Hydraulic Pumps and circuit components.

RACINE SECO

RACINE HYDRAULICS & MACHINERY, INC.
2074 Albert Street RACINE, WISCONSIN

Rigorous tests convinced BE-GE to use J-M Uneepac® in their rugged cylinders



Uneepac automatic, pressure-actuated ring packings are specified by BE-GE Manufacturing Co. of Gilroy, California, to handle the rigorous requirements of industrial and agricultural earth-handling equipment cylinders.

Uneepac proves it can handle shock pressures to 4,000 psi in three-year, life-test program

• BE-GE Manufacturing Company's line of cylinders for their hydraulic systems has to stand up to years of day-in, day-out abuse. That's why BE-GE engineers subjected J-M Uneepac Rod Packings to a 350,000-cycle test and Uneepac Piston Packings to a 150,000-cycle test in a three-year program that proved Uneepac can take working pressures to 2,500 psi—shock pressures to 4,000 psi. As proof of performance, Uneepac is now the specification packing on all BE-GE standard—and heavy-duty cylinders.

Pressure-actuated Uneepac Rings offer high-efficiency sealing in minimum packing depth. Each ring provides an efficient, individual seal—nests with adjacent rings in an interlocking manner without compression adjustment for true, multiple-ring action.

With Uneepac, you can achieve high-efficiency sealing with fewer rings, smaller stuffing boxes. For quick, easy installation, Uneepac rings are self-centering, self-adjusting. Make it a point to consider Uneepac Rings for every application requiring top packing efficiency and life.

Uneepac rings are available in all standard materials in a wide range of sizes for most rod and plunger applications. For further information, write to Johns-Manville, Box 14, New York 16, N. Y.

J-M Clipper Seals—used as rod wipers in BE-GE cylinders—keep dirt out.

JOHNS-MANVILLE

AT A FAMOUS ORDNANCE PLANT IN NORTHERN LOUISIANA:

600-Ton Lubrication Job for Cities Service!

The huge 600-ton press above is one of several at a well known Louisiana ordnance plant operated by the Remington Rand Division of Sperry Rand Corporation.

A big machine, it naturally poses a big lubrication job... but not so big that Cities Service Pacemaker Oil can't take it in stride. With unusually high viscosity index and superior fortification against oxidation, corrosion and rust, Pacemaker is a natural for the task.

Likewise, throughout the various stages of producing artillery shells—the end product—Cities Service lubricants are hard at work.

Clearly, there's little room for error here—either in the product itself or in the machines that make it. That's why Cities Service lubricants were chosen . . . and it's an equally good reason for making them *your* choice.

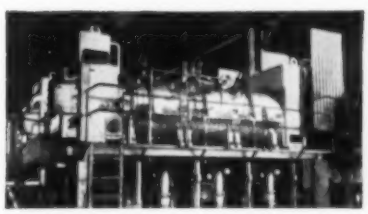
For a survey of your plant's lubrication needs, talk with a Cities Service Lubrication Engineer. Or write: Cities Service Oil Company, Sixty Wall Tower, New York 5, N. Y.

CITIES SERVICE

QUALITY PETROLEUM PRODUCTS

HOW THE ORDNANCE PLANT USES CITIES SERVICE LUBRICANTS

MACHINE	LUBRICANT
Large presses	Pacemaker 3 Hydraulic Oil
Airlines	Pacemaker 1
Speed reduction units	Pacemaker 6
Worm gear reduction units	Optimus 6
Package compressor units	Pacemaker 5
Metal working machines requiring a water soluble cutting oil	Chillo A
General Lubrication	Trojan Gear Oils, Trojan H-2 Grease

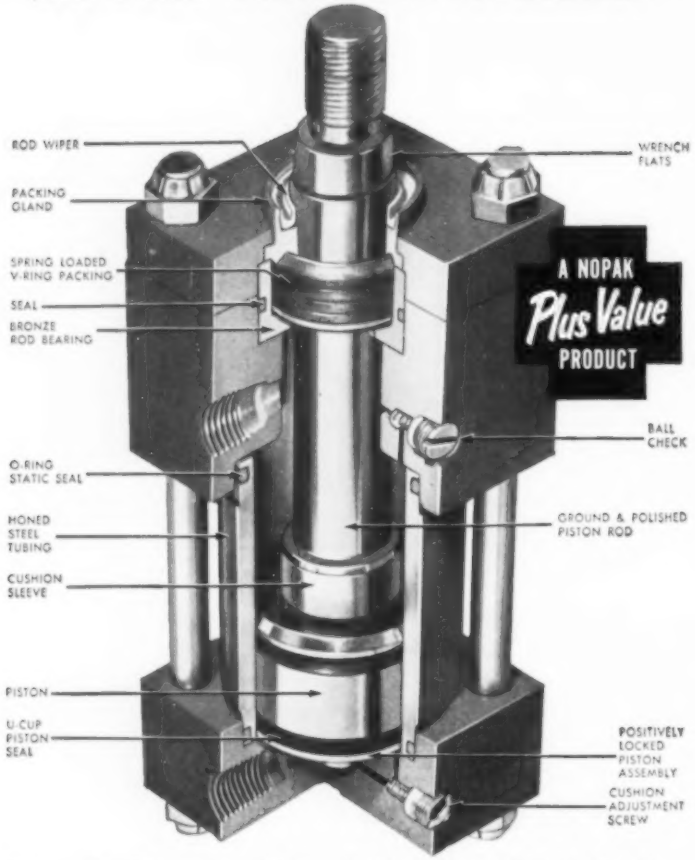


High Speed Gas Furnace heats steel to 2660 degrees F. All lubrication is supplied by Cities Service products.

Partially Finished Shells await final forming. Unusual number of forming operations are required to produce final product.

Forming Press does final forming of artillery shells. The press is lubricated by Cities Service Pacemaker Hydraulic Oil.

POWERIZE with NOPAK
for Plus Value Performance



Class 3, Square Head Hydraulic Cylinders

Pressures 3,000 P. S. I. operating, 5,000 P. S. I. proof

Check these Class 3 Plus Values . . .

- Interchangeable with other well-known square head, hydraulic cylinders
- NOPAK Class 3 Cylinders comply with J.I.C. standards
- Positively locked, one-piece concentric piston
- Piston Construction . . .
  Self-compensating U-cup *(standard)*
  Multiple seal piston ring *(optional)*
- Expansion Joint Type Tube Seal † . . .
  Cannot extrude at excessive shock pressures
  Provides bleeder by-pass location at highest internal point
  † a NOPAK *first* since 1948
- Steel Construction for Strength and Durability . . .
  Heavy Honed Steel tube, Steel heads, High Tensile Steel piston rod and tie rods
- Multiple V-Ring Rod Seal and Wiper Requires no adjustment
  Assures longest possible trouble-free operation
- Cushion Adjustment Screw and Ball Check . . .
  Maintains minimum head dimension
  Identical seats provide interchangeability
- Bore sizes from 1½" through 12"
- 18 Standard mountings
- More power per dollar

Ask for Catalog 103 . . . It contains complete Data and Dimensions.

NOPAK VALVES and CYLINDERS

GALLAND-HENNING NOPAK DIVISION • 2743 S. 31st Street • Milwaukee 46, Wisconsin

LETTERS to the editor

Address your letters to: Editor, APPLIED HYDRAULICS & PNEUMATICS MAGAZINE, 812 Huron Rd., Cleveland 15, Ohio.

Needs Air Components

TO THE EDITOR:

We are in need of some small air components which we would use on models now being made. We prefer using a standard product if possible. We need: an air compressor—compact unit with 110 volt motor to supply ½ cfm at 50 psi; air cylinder—stainless steel body and rod, 16 in stroke and ½ in outside diameter.

VICTOR POKORNY
Superintendent
Blakeslee & Co.
Chicago, Ill.

Names of manufacturers have been sent.

Electric Pump Drives

TO THE EDITOR:

The article in the March issue by Mr. Asquith on the Lockheed Electra's hydraulic system states that the Electra is the first commercial transport to use all-electric pump drives. The Britannia Series 300 entered airline service last year and has all of its main pumps and the emergency pump electrically driven.

Your distilled writing certainly makes the articles easy to read, but does it tend to miss some important facts? For example, in the above article the author states that power for emergency braking may also be supplied from an air bottle charged to 3000 psi. This implies that air enters the braking system and would require bleeding after each emergency operation. Is this the case, or does the air pressure force oil into the system?

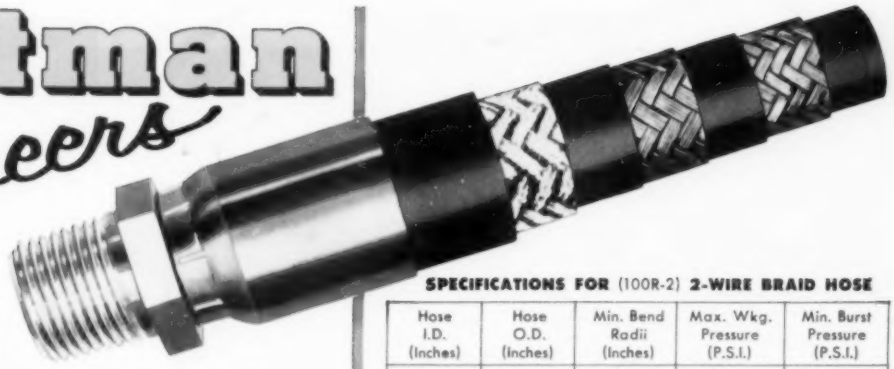
E. G. COLLINSON
Asst. Chief Engr.
British Messier Ltd.
Gloucester, England

The Lockheed people tell us that in the event of hydraulic system

Continued on page 22

Eastman

engineers the way TO HIGHER PRESSURES



Eastman engineering is making possible ever-increasing advances in hydraulic pressures through:

- Couplings designed to exceed minimum *burst* pressure —four times actual working pressure.
- Hydraulic application of couplings to hose, assuring maximum grip—within specified hose tolerance.
- Maximum orifice—designed to improve fluid flow, reduce friction and increase power delivery.
- More rigid testing of completed assemblies to reveal additional opportunities for improvement.

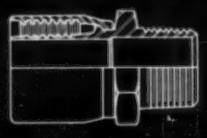
Let Eastman engineers help you increase the "power-performance ratio" of your product to improve your competitive position in your field.

SPECIFICATIONS FOR (100R-2) 2-WIRE BRAID HOSE

Hose I.D. (Inches)	Hose O.D. (Inches)	Min. Bend Radii (Inches)	Max. Wkg. Pressure (P.S.I.)	Min. Burst Pressure (P.S.I.)
¼	11/16	4	5000	20000
⅜	27/32	5	4000	16000
½	31/32	7	3500	14000
¾	1 ¼	9½	2250	9000
1	1 5/16	9½	1875	7500
1 ¼	2	16	1625	6500
1 ½	2 ¼	20	1250	5000
2	2 ¾	22	1125	4500

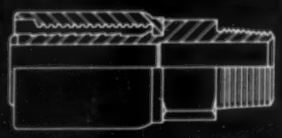
PERMANENTLY ATTACHED COUPLINGS

For 2-wire braid hose. Offers maximum coupling strength, strong hose attachment and improved orifice for rapid, friction-free fluid flow. For working pressures up to 5000 psi. See Pages 10 and 11.



HIGH PRESSURE COUPLINGS

For EXTREME high pressures up to 7000 psi working pressure. Eastman engineered for greater power delivery and performance. For specifications and sizes, send for New Eastman Bulletin 200, below.

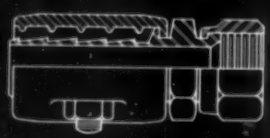


2-PIECE REUSABLE COUPLINGS

For 2-wire high pressure hose up to 5000 psi working pressure. Increases serviceability of your equipment through easy replacement in the field. See new Bulletin for complete details.

CLAMP TYPE COUPLINGS

Accurate machining assures alternate positioning of clamp ribs between each barb of insert—creating exclusive Inter-Lock grip—available to you only through Eastman. Pages 14 and 15.

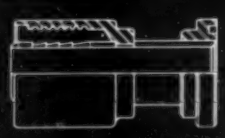


SWIVEL "O" RING MALE COUPLINGS

Permits easy assembly in close quarters, easy positioning of hose in 45° and 90° angles. Economical, reduces number of threaded connections. Dimensional drawings, sizes, and specifications in new Bulletin.

FLANGE HEAD COUPLINGS

Offer advantages of permanent hose attachment plus Split Flange Head Couplings with 0° to 90° stems. Economy plus user convenience. Specifications and sizes listed in new Bulletin.



TUBING ASSEMBLIES

Swivel Male "O" Ring Tube Nut used on tubing assemblies. Eastman offers formed tubing with beaded or flared ends—to your requirements. Specifications and sizes on Page 30.

Eastman
first in the field
MANUFACTURING COMPANY
Dept. AH-9, MANITOWOC, WISCONSIN

Write FOR YOUR NEW BOOK— WITH THAT NEW LOOK!

- A NEW Service Concept.
- A NEW High in Convenience.
- A NEW Ease in Specifying— according to your pressure requirements.

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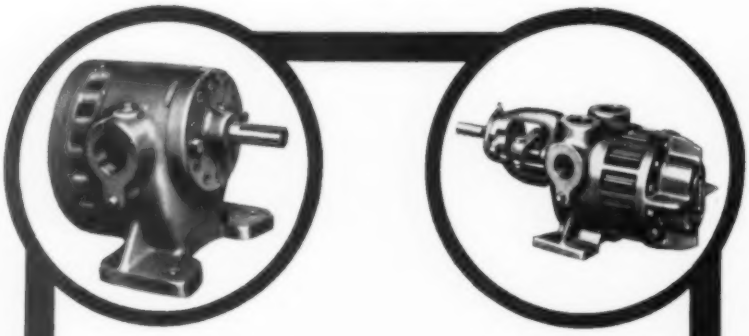

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Today perhaps your requirements are for *hydraulic applications* . . . next week for *processing equipment* . . . next month for *pressure lubrication* on industrial equipment. Whatever the need, Roper has the *right pump* for you—to do the job better!

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Roper's basic principle employing two equal size pumping gears lends itself to wide flexibility in designing custom pumps. You name the P.S.I., the G.P.M., the port arrangement required, plus other data and we'll work with you in developing rugged, dependable equipment.

MANY STANDARD ROPERS ARE ADAPTABLE TO YOUR NEEDS

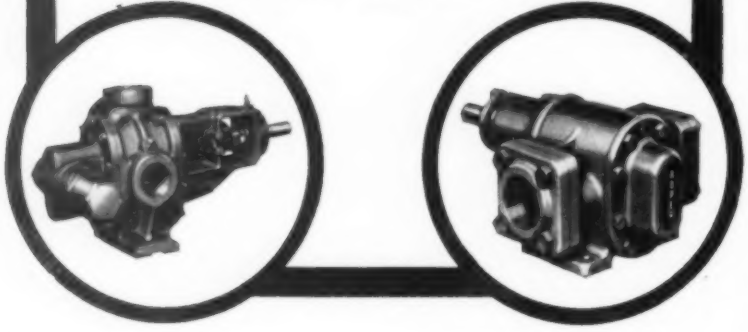
With a large selection of both standard and special units from which to choose, substantial savings in designing and engineering costs can be affected. A look at your specifications will tell us if such standard Ropers can be adapted or modified for your needs

Send for Free Booklet

"HOW TO SOLVE PUMPING PROBLEMS"

ROPER
ROTARY PUMPS

ROPER HYDRAULICS, INC.
709 Blackhawk Park Ave., Rockford, Ill.



LETTERS

failure the air is applied to the wheel cylinder through a shuttle valve mounted directly on the cylinder. This blocks off the hydraulic system so that it does not become charged with air. However, the wheel brake cylinder itself would require bleeding after an emergency operation.

Wants Heiser Book

TO THE EDITOR:

We are very interested in the article "How to Stop Air Cylinders Smoothly" by Elmer Heiser published in the June issue. How can we order a copy of the book Air and Oil Cylinders in Industrial Applications?

B. L. McCLINTIC
General Electric Co.
Atomic Power Equipment Dept.
San Jose, Calif.

Elmer Heiser's book can be ordered from us. Price per copy is $5.00. You will find his book very valuable in the proper application of hydraulic and pneumatic cylinders.

Fluid Power Courses

TO THE EDITOR:

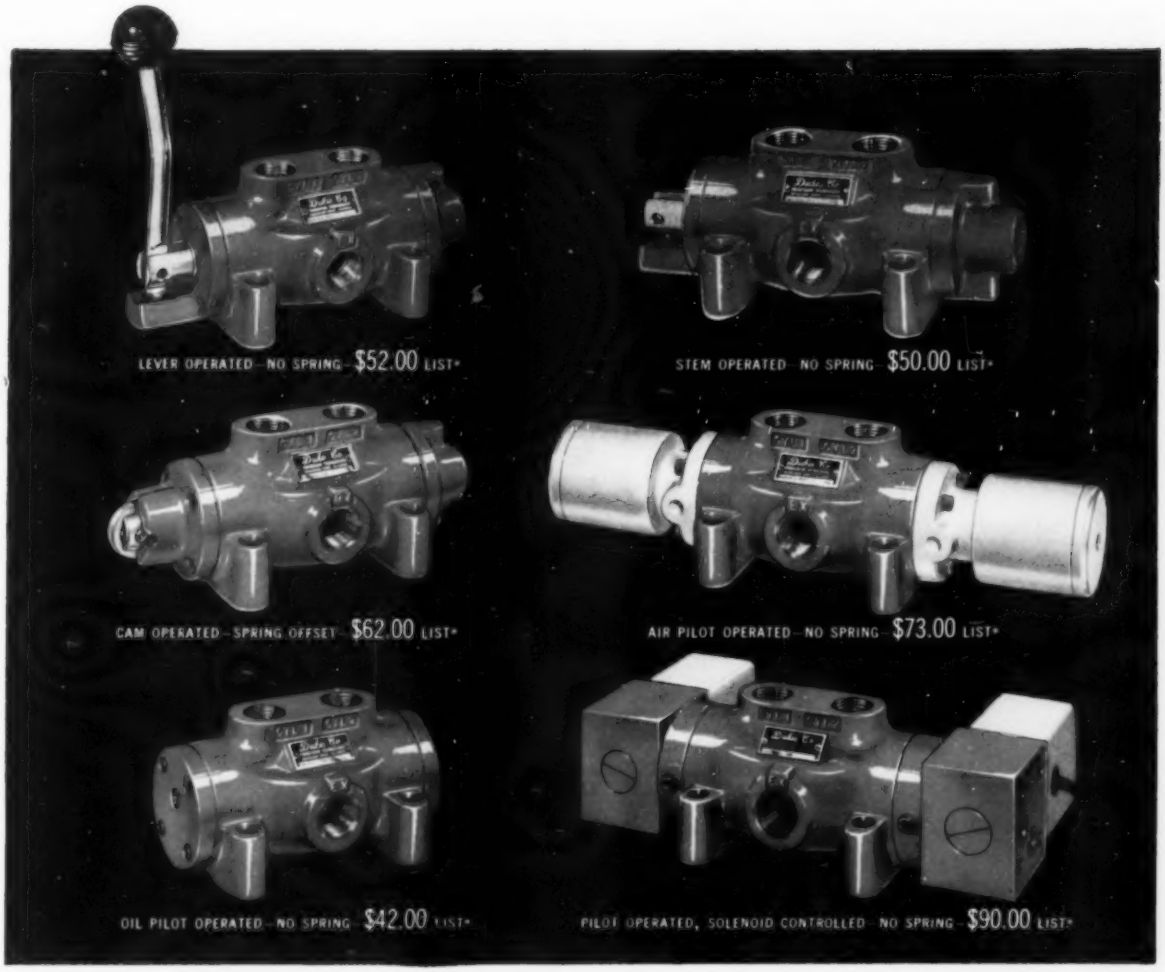
Several times in the past I have noticed mention of schools with short courses in hydraulics and pneumatics. I am interested in such a course and would appreciate any information you could send me.

RALPH M. ROOKE, SR.
The Fuller Brush Co.
Hartford, Conn.

At the present time we don't have any information on schools in your area that offer specialized courses in hydraulics and pneumatics. A survey is now being conducted by the National Fluid Power Association to determine what courses are being offered throughout the country. It will probably be a year before this information is available.

Attached is a tear sheet about a correspondence course which may be of interest.

Continued on page 24


LEVER OPERATED—NO SPRING—$52.00 LIST*
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CHECK the prices! COMPARE the specs!

You'll find this NEW line of valves costs less and operates to higher requirements

. . . and TANDEM SPOOLS are available at no extra cost

- Available for pressures up to 3000 PSI
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Use Chemiseal® NYLON PRESSURE TUBING

outperforms metal

STRONG Types for 1000 psi and 2500 psi.

FLEXIBLE Saves flexible couplings, and intermediate fittings.

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ADAPTABLE Sizes from 1/8" to 1/2" O.D. —useable with any standard metallic flare or compression fittings.

SERVICEABLE At temperatures ranging from −100°F to +225°F. Unaffected by hydraulic fluids, oils, alkalies, most solvents.

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LETTERS

Motorized Relief Valve

TO THE EDITOR:

On page 79 of the June issue was an article describing the use of a motorized relief valve. Could you tell us if such an actuator is commercially available and where we could get additional information on it.

E. S. KEYSER
Hydraulic Engineering Supervisor
Lake Erie Engineering Corp.
Buffalo, N. Y.

Name of the manufacturer has been forwarded.

Hydraulic Manifolds

TO THE EDITOR:

We receive APPLIED HYDRAULICS and also have your FLUID POWER DIRECTORY. Both have been very helpful to us. Both journals are very complete; however, we would like additional information on companies that make hydraulic valve manifolds. Should you have such a listing, we would appreciate you sending us a copy.

S. D. ODERMAN
Ass't Director R & D
Wood Newspaper Machinery Corp.
Plainfield, N. J.

A list of the manifold manufacturers has been forwarded.

Back Issues

TO THE EDITOR:

APPLIED HYDRAULICS has published several engineering articles on hydraulic flow compensating controls for multiple circuits. Please send and bill us for all 1957 issues.

FRANK L. MACWATTY
President
Asano Bussan Co. of New York, Inc.

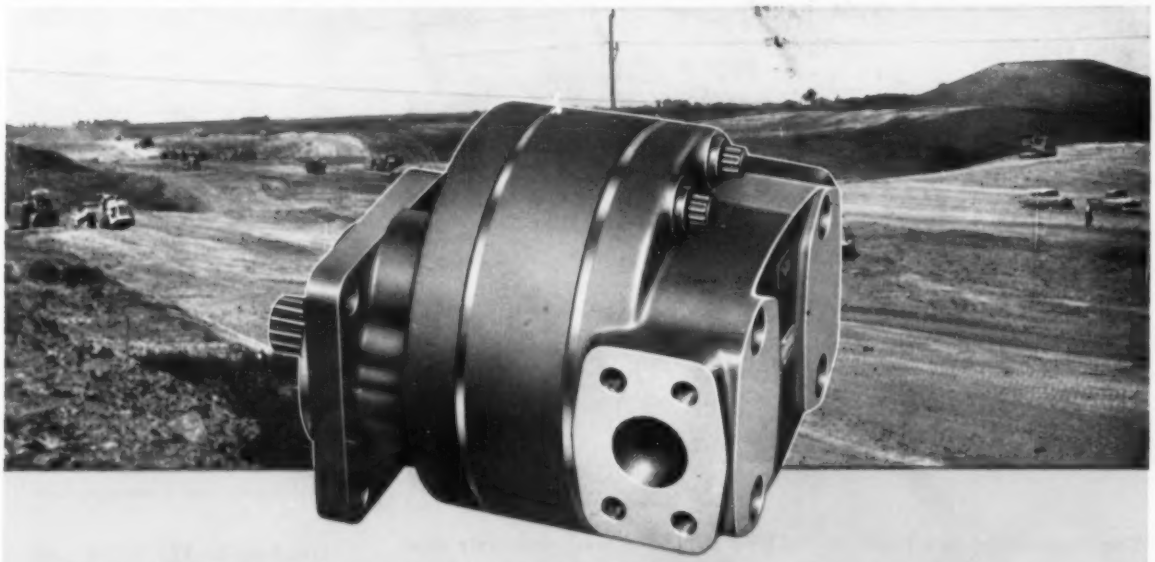
We're out of many of the 1957 issues. A December issue gives our complete 1957 editorial index. Select the articles you want. We'll be glad to send tearsheets, if available, or photocopies. Photocopies of any article cost 10c per page.

An excellent source of circuit information under one cover is the FLUID POWER DIRECTORY. Price of this 796 page volume is $6.50. ▼▼▼

capacity for Big payloads

Now you can have all the advantages of Webster pumps in capacities up to 124 gpm. New "HF" series are high capacity, gear-type pumps especially designed for heavy earth moving and construction equipment. Built to perform under heavy shock loads, long continuous operation. The "HF" series is available in 5 sizes, with capacities from 18 to 124 gpm, operating pressures up to 1500 psi and operating speeds to 2400 rpm. Like all Webster hydraulic pumps, the new big capacity series is compact for easy adaptation to your product . . . operate at maximum efficiency on low power requirements.

NEW Webster "HF" SERIES HYDRAULIC PUMPS



These Webster features mean QUALITY!

1. **Integral drive, idler shaft and gear assembly.**
2. **High capacity roller bearings at all four bearing points.**
3. **Ball bearing to absorb end thrust.**
4. **Internal splined shaft (no keying problems).**

WRITE for facts, figures and data on the new Webster "HF" series pumps.

Call the man from Webster

OIL HYDRAULICS DIVISION

WEBSTER ELECTRIC

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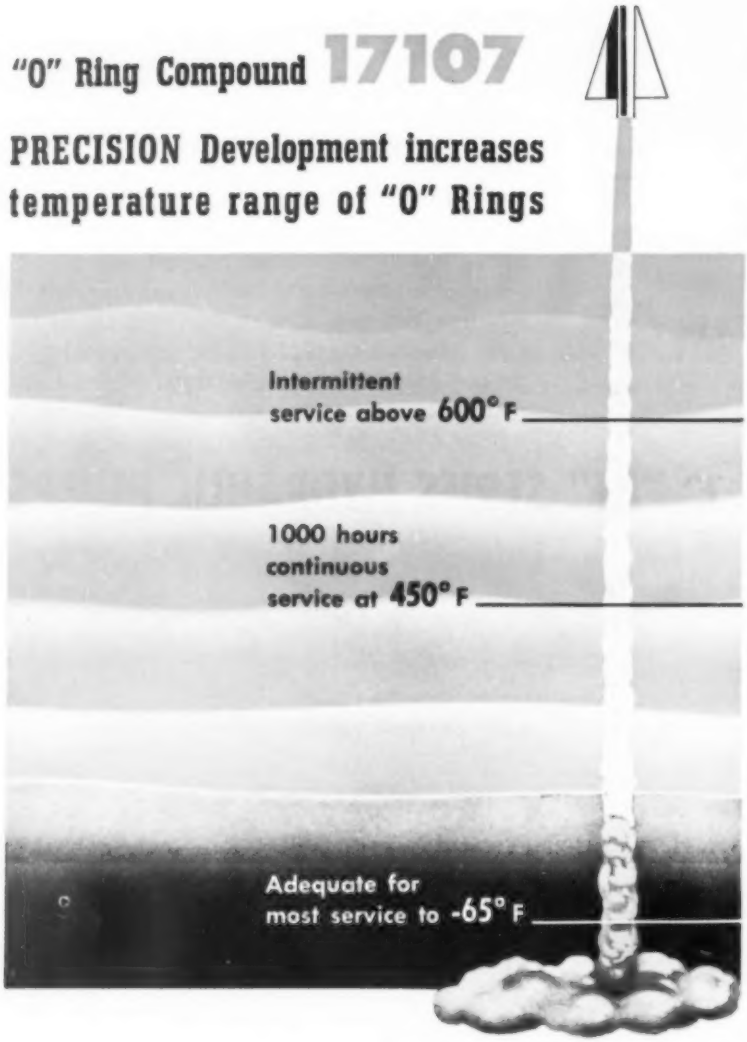
CAPACITY RANGE OF "HF" SERIES PUMPS

Ratings shown are tentative standards which may be changed to meet your own requirements.

MODEL	GEAR WIDTH, INCHES	DISPLACE. CU. IN. PER REVOLUTION	GPM @ 1200 RPM & 1000 PSI	GPM @ 1800 RPM & 1000 PSI	GPM @ 2400 RPM & 1000 PSI
10 HFS	1	4.3	18	30	41
15 HFS	1½	6.5	28	45	61
20 HFS	2	8.6	38	60	83
25 HFS	2½	10.8	52	76	112
30 HFS	3	13.0	59	92	124

"O" Ring Compound 17107

PRECISION Development increases temperature range of "O" Rings



This dramatically new Precision "O" Ring compound seals effectively over the range of −65° F up to 500° F with this maximum range dependent on service conditions. Has exceptionally low compression set, unusually low volume change, resistant to destructive chemicals, exotic fuels, synthetic lubricants, hydraulic fluids and ozone. Meets the most severe military specification for high temperature service elastomers. (Write for data.)

Precision Compound 17107 (based on DuPont Viton A) is typical of the many developments that have made Precision Rubber the recognized leader of the industry.

For the answer to your sealing problems ask for the services of the Precision Engineer.

"O" Rings—Rubber Bonded to Metal—Rubber Seals and Gaskets

Precision Rubber Products Corporation • "O" Ring and Dyna-seal Specialists

Dept. 1, Oakridge Drive, Dayton 7, Ohio Canadian plant at: Ste. Thérèse de Blainville, Québec

FUTURE EVENTS

September 15-19: Instrument Society of America, 13th annual instrument automation conference and exhibit, Convention Hall, Philadelphia, Pa.

September 22-24: Standards Engineers Society, 7th annual meeting. Benjamin Franklin Hotel, Philadelphia, Pa.

September 29-October 3: ASTE Semi-Annual Meeting and Western Tool Show. Shrine Exposition Hall, Los Angeles, Calif.

September 29-October 4: SAE Aeronautic meeting, aircraft manufacturing forum, and engineering display, The Ambassador, Los Angeles, Calif.

October 13-15: ASME-ASLE Lubrication Conference, Statler Hotel, Los Angeles, Calif. Papers will be presented on lubrication, wear, and high temperature. For further information contact R. B. Purdy, 150 East 42nd St., New York City.

October 14-16: Society of Industrial Packaging and Material Handling Engineers. National Exposition, The Coliseum, Chicago, Ill.

October 16-17: NCIH 14th Annual Meeting. Sherman Hotel, Chicago, Ill. For complete information write Raymond D. Meade, Conference Secretary, Illinois Institute of Technology, Chicago, Ill.

October 27-31: American Society for Metals, National Metal Exposition and Congress. Public Auditorium, Cleveland, Ohio.

November 3-5: National Fluid Power Association fall meeting, Drake Hotel, Chicago, Ill. For information write Barret Rogers, Executive Secretary, 1618 Orrington, Evanston, Ill.

December 4-5: Industrial Engineering Conference, Illinois Institute of Technology, Chicago, Ill. ▼▼▼

T-J spacemaker cylinder

Quality Engineered

to give quality results

with Extras . . . at No Extra Cost!

You get more—much more—when you specify and use any of T-J's complete line of Spacemaker cylinders. The Spacemaker is engineered to give you better, more accurate, and longer service—offers, exclusively, many extras . . . that are STANDARD, AT NO EXTRA COST!

Designed to eliminate tie-rods, providing greater strength . . . saves space . . . reduces manhours and costs in all push-pull-lift operations. IMMEDIATE SHIPMENT in a wide range of styles and capacities, with 64,000 combinations. Write for Bulletin SM 155-3 with complete engineering details. The Tomkins-Johnson Co., Jackson, Mich.

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BUILDERS AIR AND HYDRAULIC CYLINDERS, CUTTERS, CLINCHERS

METAL PISTON ROD SCRAPER . . . Standard at No Extra Cost!

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CHROME PLATED CYLINDER BORES AND PISTON RODS . . . Standard at No Extra Cost!

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NO TIE-RODS TO STRETCH . . . Standard at No Extra Cost!

STREAMLINED DESIGN . . . Oil Pressure to 750 P.S.I.—air to 200 P.S.I. Standard at No Extra Cost!

FORGED SOLID STEEL HEADS . . . Standard at No Extra Cost!

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NATIONAL OIL SEAL LOGBOOK

Ask yourself these questions when specifying oil seals

SHAFT RPM, FPM, RUNOUT, ENDPLAY	Is seal rated at or above my anticipated operating extremes? ☐ YES ☐ NO
TEMPERATURE, LUBRICANT TYPES	Will heat or special-purpose lubricants attack my sealing lip compounds? ☐ YES ☐ NO
PRESENCE OF DIRT OR OTHER FOREIGN MATERIAL	Point often overlooked. If present, should I specify dual-lip sealing member? ☐ YES ☐ NO
COST RELATED TO SEAL DESIGN	Will a simpler, less expensive seal do as good a job as a more sophisticated unit? ☐ YES ☐ NO
NEW SEAL DESIGNS AND MATERIALS ON MARKET	Are there new high temperature, high speed compounds I should examine before specifying? ☐ YES ☐ NO
SPECIAL DESIGNS FOR SPECIAL PROBLEMS	Not all sealing jobs can be met with stock seals. Do I need a special factory design? ☐ YES ☐ NO
DELIVERY, REPUTATION FOR QUALITY	Is my resource noted for on-time delivery, uniform quality, and good follow-up service? ☐ YES ☐ NO

Don't specify "blind." Your National Oil Seal Engineer has up-to-date data on seals—old, new and under development. He understands current sealing parameters; what special designs can probably be developed. His frank, free counsel can't help but lead to better sealing, faster assembly, simpler servicing, faster delivery or lower cost.

Call him today. Number's in the Yellow Pages, under Oil Seals.

NATIONAL SEAL
Division, Federal-Mogul-Bower Bearings, Inc.
General Offices: Redwood City, California
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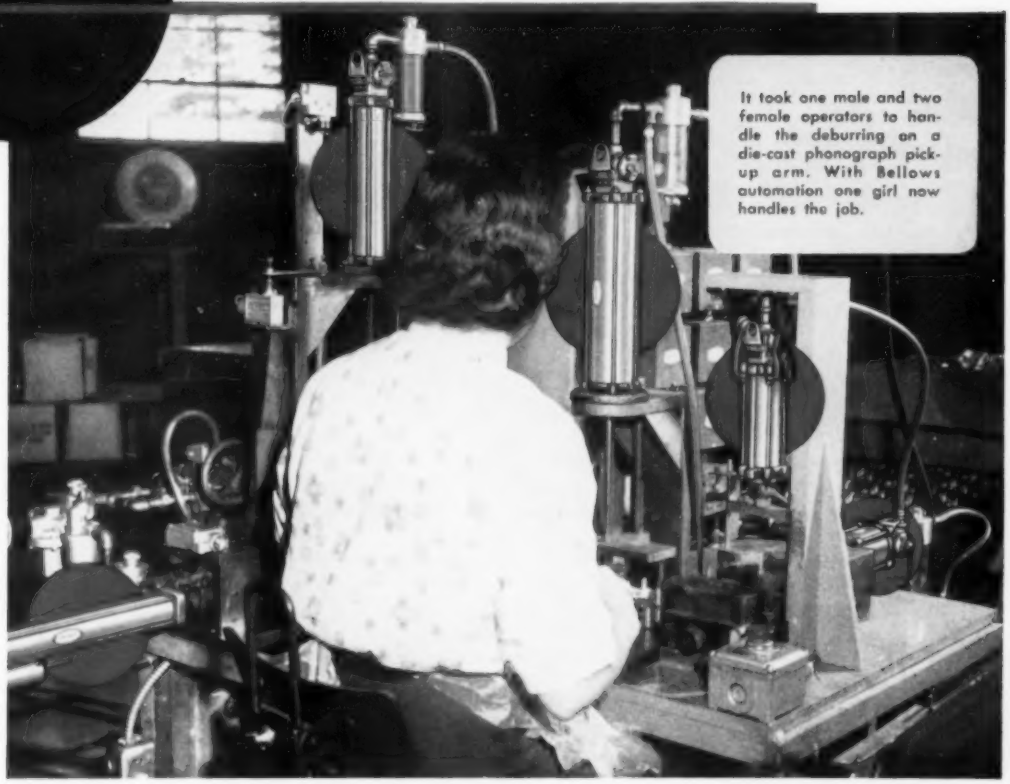
CIRCLE 97 ON TIME-SAVER CARD

"SPOT-A-MATION"



It took one male and two female operators to handle the deburring on a die-cast phonograph pick-up arm. With Bellows automation one girl now handles the job.

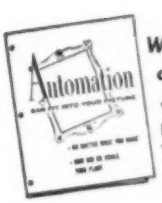
...a fast way to important cost savings

Any plant, no matter how large, consists of many "small plants" or separate manufacturing centers. Sometimes these separate manufacturing centers consist of no more than a single operation; sometimes they embrace a group of related operations.

A quick approach to important cost savings can be to "spot automate" these separate "small plants" with Bellows Controlled-Air-Power Devices.

These packaged work units can be quickly incorporated into existing equipment to make it fully automatic; can be used to interlock or program a number of machines or operations; or can form the key components in low-cost, tool room-built, special purpose machines.

A Bellows Field Engineer (there is one or more in every major industrial area in the United States and Canada) will be glad to discuss with you the ways you can use to "spot automate" your plant. No obligation, of course. Phone him (he's in the book under "The Bellows Co.") or write to us in Akron.



Would you like a copy of this booklet?

Write Dept. AH 958. Ask for the booklet—"Automation can fit into Your Picture."

The Bellows Co.

DIVISION INTERNATIONAL BASIC ECONOMY CORPORATION

AKRON 9, OHIO

1126-B

BRIEFS

about fluid power

HYDRAULICS HELP MAKE WAREHOUSING AUTOMATIC

One man can operate a new, automatic warehousing system. Introduced recently by Automatic Warehousing Branch, Pesco Products Div., Borg-Warner Corp., the system is made up of rows and tiers of racks supporting sloped rails. Pallet adapters fitted with wheels make a small railway car of an ordinary pallet so it can run on these rails. A loader truck which runs on rails at ground level on one side of the tier of racks, a similar unloader truck that works on the other side of the tier, and a control system complete the package.

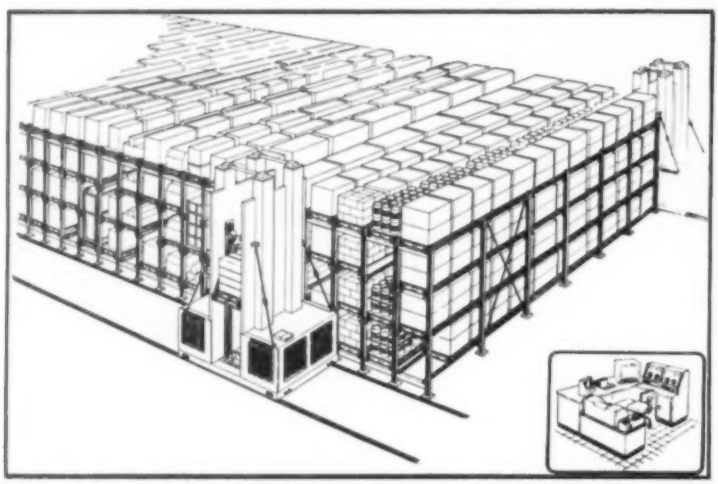
The operator feeds the information to control the loading and unloading trucks to a control console. The truck then automatically finds the right spot, elevates to the correct level, and loads or unloads a pallet. Pallets loaded into the racks run downhill on their wheels to the unloading side. Beside the advantage of using only one man to run the setup, space is better used because no aisles are needed, and stacking height is not limited by what the bottom pallet can support.

Hydraulic cylinders on the loader and unloader trucks are used for two jobs. One is to center the truck on the opening in the rack where the pallet is to be put; the other is to raise the pallet from the short rail sections on the loader and to lower it onto the rails in the rack. The same jobs must, of course, be done during unloading.

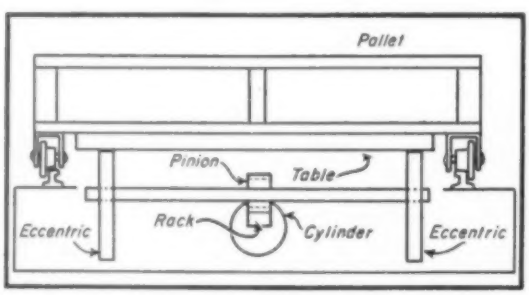
To center the truck on the right rack, a pair of hydraulic cylinders swings a pair of arms out from a position flush with the sides of the truck so the arms embrace the columns and thus move the truck to line it up. Rough positioning is done by stopping the truck drive motor when an electric eye device has counted the required number of feet from the starting point.

Hydraulic-cylinder-driven racks and pinions turn shafts to which eccentrics are keyed to lift the

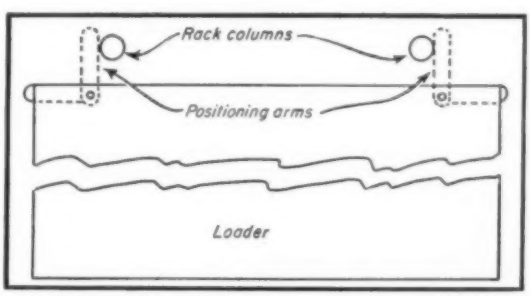
Continued on page 32



ROWS AND TIERS of racks are fed and unloaded by automatic lift trucks. One man controls the system from a control desk.



ECCENTRICS DRIVEN by hydraulic cylinders through racks and pinions raise and lower pallets.



HYDRAULIC CYLINDERS swing arms for accurate loader or unloader positioning.

C/R now offers you the advantages of reinforced TFE... designed, compounded and molded by a single source!

If your work involves sealing applications, you are probably familiar with "Teflon", Tetrafluoroethylene Resin. The extreme versatility of its chemical, thermal and mechanical properties are unmatched by any other material on the market.

You may not be, however, fully aware of the degree to which these properties can be distinctly improved by the use of reinforcing inorganic additives. For example, "Teflon" can be blended with inorganics to increase:

- **Resistance to deformation under load — by a factor of 10**
- **Resistance to wear by rotating shafts — by as much as 500 times**
- **Stiffness — by a factor of 4-5**
- **Thermal conductivity — by a factor of 5-10**
- **Compressive strength — by a factor of 3-4**
- **Hardness — by 10%**

It is also useful to know that Chicago Rawhide is one of the few fabricators which blends its own "Teflon" compounds, assuring constant quality in batch after batch and permitting compound formulations to be developed rapidly and accurately. Our new laboratory and production facilities are unexcelled – and these facilities are matched by our experience in molding synthetic parts to meet the most critical specifications.

C/R Sirvene welcomes the opportunity to cooperate with you in the design and production of "Teflon" and reinforced "Teflon" packings, bearings, gaskets, rings, or other parts.

If you are interested in "Teflon" write for your free copy of Sirvene Materials Bulletin CT-1.

*"Teflon" is a DuPont registered trademark

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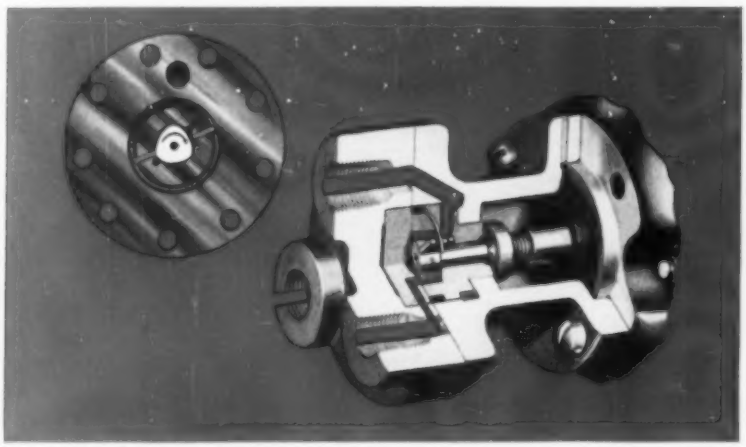
YESTERDAY'S PIONEER . . . TODAY'S LEADER

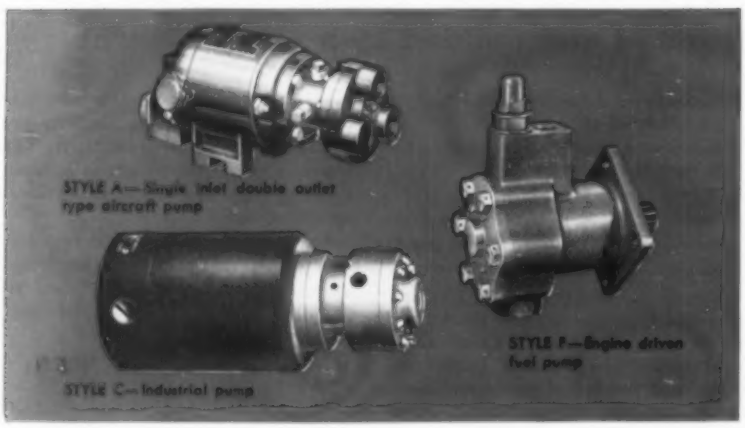
WELDON / FLUID METERING PUMPS

Positive Displacement Rotor Type. For Industrial Applications, Aircraft Anti-Icing and Aircraft Fuel.



IT'S SO SIMPLE!

The rotation of the rotor draws the fluid in through two passages, filling the cavities formed by the three lobes of the rotor. This fluid is sealed within these small cavities until it is forced through the two outlet holes by the floating blades. The flow may be kept uniformly divided through two outlet ports, or may be combined internally for passage through a single port.



COMPACT • LIGHT WEIGHT

Send for Weldon Manual and Catalog with detailed specifications and installation drawings, covering the full range of Weldon pumps in various capacities. Specify your requirements.

40 YEARS OF LEADERSHIP 1918—1958

THE WELDON TOOL COMPANY

3000 WOODHILL ROAD · · · CLEVELAND 4, OHIO

CIRCLE 151 ON TIME-SAVER CARD

BRIEFS

loader table and pallet from the rails on the loader when a pallet is to be placed in the racks. The table then is moved into the racks. Reversing oil flow to the cylinder lowers the pallet onto the rails in the racks. ▼▼▼

TO ACCOMMODATE cylinder for driving a modified planer an addition had to be built on the plant of Tufts Machine, Westboro, Mass.

Truck Hoist Lifts 2000 Lbs

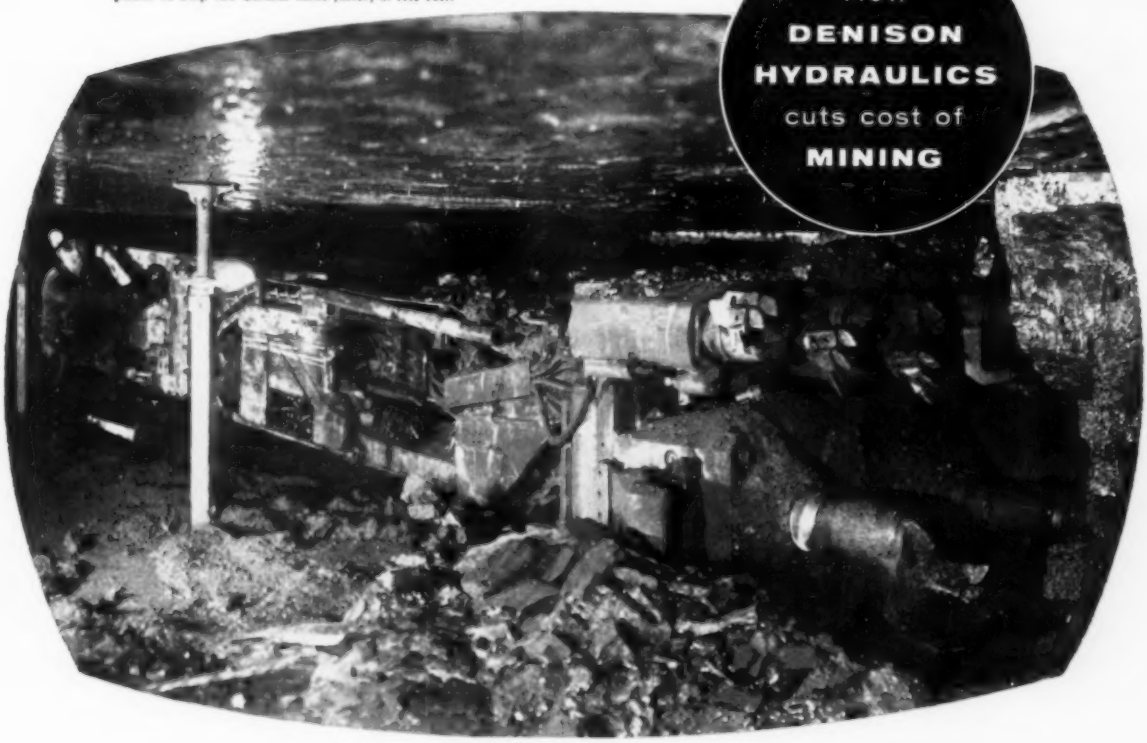
One man can lift or load 2000 lbs. with this heavy duty utility hoist. Made by Unit Mfg. Co., Minneapolis, Minn., it is all hydraulically operated. Turns 360 degrees to handle loads in any

position. The unit can be operated from a hydraulic system on the truck, or supplied with a battery operated power pack. The boom extends 8 feet and is raised and lowered with a lever operated valve. Hoist may also be mounted on loading docks. ▼▼▼

Continued on page 39

FAMOUS JEFFREY COLMOL®... continuous mining machine made by The Jeffrey Manufacturing Co., Columbus, Ohio—shown operating in 42" coal. Production: over 800 tons per shift. *Denison hydraulic equipment assures instant, dependable hydraulic power to help the Colmol mine faster, at less cost.*

How **DENISON HYDRAULICS** cuts cost of **MINING**



Instant-acting **DENISON** hydraulic power helps **JEFFREY** Colmol® devour over 800 tons per shift

TOUGH MINING doesn't stop Jeffrey's famous Colmol®. This powerful, compact continuous coal-mining machine works efficiently under the most severe operating conditions—producing over 800 tons per shift. *And the Colmol counts on dependable Denison hydraulic power for instant, accurate control that results in fast, low-cost mining.*

The Colmol's simplified, easily accessible hydraulic system includes a wide range of rugged Denison hydraulic equipment—four 2000 psi Vane-type Pumps..., four Fluid Motors... plus flow controls, relief and check valves.

Three of the Vane Pumps power four Fluid Motors which drive the Colmol's two crawler treads, two discharge conveyor chains, and a swinging discharge conveyor chain.

The other Vane Pump operates 8 hydraulic cylinders which separate the Colmol's top and bottom head sections to adjust the breaker arms for working various coal seam heights... raise, lower and tilt the entire Colmol mining head.

Added advantages—Denison hydraulic power provides *infinite speed adjustment* for the Colmol. Simple hydraulic controls allow *one operator* to vary the machine's feed speed from zero to 46 inches per minute for mining... and from zero to 23 feet per minute for high or low-speed tramming in forward or reverse. This is *hydraulic flexibility that pays off* in today's modern mining operations.

It's another example of hardworking Denison hydraulic power doing jobs better... faster throughout industry. Your Denison Hydraulic Specialist can help with *your* next design problem. Write us for details.

HYDRAULIC DRIVE for the Colmol... begins with 4 Denison 2000 psi TMC Vane Pumps—shown assembled on gear case with electric motor attached. Three Vane Pumps power four Fluid Motors which drive crawler treads and conveyors. Remaining Vane Pump operates eight multi-purpose hydraulic cylinders.

DENISON ENGINEERING DIVISION
American Brake Shoe Co.
1166 Dublin Road • Columbus 16, Ohio

Denison and Denison HydrOILics are registered trademarks of Denison Eng. Div., ABSCO

DENISON HydrOILics
HYDRAULIC PRESSES • PUMPS • MOTORS • CONTROLS

Denison Stocking Branch Offices: LOS ANGELES • CHICAGO DETROIT • ATLANTA • HOUSTON • NEWARK • CLEVELAND

CIRCLE 35 ON TIME-SAVER CARD

Tubexperience in action

Your carbon hydraulic tubing with Superior

gets 100% permanent protection rust preventive!

*Superior (SAE) Carbon Hydraulic gives you the smoothest, most brilliant ID and OD finish you can buy. Made from non-aging steel. Carbon content is only .12% maximum for high ductility. Every length is 100% hydrostatically tested. You get maximum performance and minimum turbulence, plus long service life.

You get all this, *plus one important extra that makes Superior hydraulic tubing your best investment—a rust preventive that gives 100% positive protection indefinitely!*

Just dip it and use it! Superior rust preventive comes off easily, leaves tubing clean and bright, just like new.

GET EXTRA SAFETY WITH SUPERIOR

There is a reason for use of the special rust preventive on Superior hydraulic. Thin oil coatings are not sufficient protection. They will bleed or rub off—and when the tubing is to be used, it shows patches of rust and pin spots where pitting has begun. The tubing no longer meets specifications, because that marred ID is sure to cause pressure trouble and excessive turbulence. But the high protection you get when you buy Superior hydraulic assures you of tubing that is always ready for service, weeks or months after you buy it.

Each length of Superior hydraulic tubing gets an all-important coating of rust preventive. This microcrystalline wax material sheathes the tube in an unbroken film inside and outside. It sets quickly, will not run or rub off during shipment, is not slippery or messy to handle, will not bleed over your storage racks. Tubing is safeguarded against rusting, corroding, staining or tarnishing in damp or corrosive atmospheres.

EASILY REMOVED

The rust preventive can be removed as simply and quickly as lighter, less efficient coatings. Simple immersion for a 5-minute maximum in any of a variety of standard cleaners (Stoddard, kerosene, cleaning solvents such as trichloroethylene, or commercial alkali cleaners) is sufficient.

A REMINDER

Remember—normally you buy your tubing from a distributor (a steel service center). To give you the best possible service, he must stock carbon hydraulic in his racks. It may be there a month or two—even longer. But if you specify Superior (SAE) Carbon Hydraulic, you know it will reach you as bright and shiny as the day it was drawn. Just dip it and use it!

Superior hydraulic tubing is available through leading steel service centers from coast to coast. For the name of your local Superior Tube distributor and a free copy of Bulletin 39, write to Superior Tube Company, 2030 Germantown Ave., Norristown, Pa.

Superior Tube

THE BIG NAME IN SMALL TUBING

NORRISTOWN, PA.

All analyses .010 in. to ⅜ in. OD—certain analyses in light walls up to 2½ in. OD.

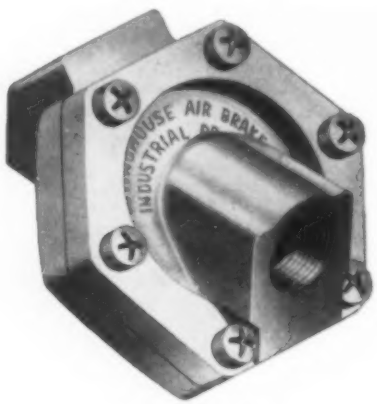
West Coast: Pacific Tube Co., 5710 Smithway St., Los Angeles 22, Calif. • RAymond 3-1331

New Product Announcement

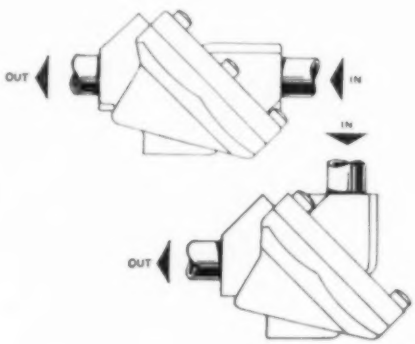
WESTINGHOUSE QUICK RELEASE VALVE

light weight...flexible mounting...more sensitive control

Here is the new Westinghouse Quick Release Valve. Its all-new design features a number of improvements which make it the most efficient device you can use to vent air-pressure cylinders and other pneumatic equipment.



Only 7 ounces!—The Westinghouse Quick Release Valve is made of aluminum—it weighs only seven ounces. It is ideally suited to meet installation requirements where weight is an important factor.



No bracket needed—A key feature of this valve lies in the flexible mounting of its supply port, allowing the inlet and outlet ports to be assembled on the same center line or at right angles to each other. In addition, you need no bracket to install the new Westinghouse Quick Release Valve.

Unmatched response—This new device provides one of the most sensitive controls yet offered in a valve of this type. Because of its design, the Westinghouse Quick Release Valve will respond to pressure changes as low as 6 psi.

Other advantages—Westinghouse Quick Release Valves have larger internal passages, allowing them to exhaust greater volumes of air quickly and efficiently. These valves have been engineered so that centrifugal force will not affect their performance when mounted on rotating or revolving devices. Constructed of sturdy, corrosion-resistant aluminum, these valves will deliver long, trouble-free performance with minimum maintenance. The diaphragm of the Westinghouse Quick Release Valve is oil-resistant and its special design provides quiet operation.

To speed the operation of any pneumatic circuit, order the new Westinghouse Quick Release Valve from your local distributor. Price: $5.25. Quantity discounts available.

See the yellow pages under Cylinders for the name of your local distributor.

Westinghouse Air Brake
COMPANY
Industrial Products Division
WILMERDING PENNSYLVANIA

CIRCLE 152 ON TIME-SAVER CARD

CIRCLE 37 →

Decco

PRESENTS

MINIATURIZED INDUSTRIAL SOLENOIDS *with multi-million cycle performance!*

THESE ARE INDUSTRIAL QUALITY SOLENOIDS!

Decco 01 series produces 1.7 lbs. force at ½" stroke. Quiet hold at 4¾ lbs. force. Decco 02 series produces 2.4 lbs. force at ½" stroke. Quiet hold at 5½ lbs. force. Both series are available in push or pull models, vertical or horizontal mounting.

Decco's series 01 and 02, miniature, AC solenoids have all the fine qualities of their well known, standard size, companion models. Quality and performance are the same—only the size has been changed . . . and thorough "in service" testing has proved them worthy of the Decco name.

These miniature solenoids are built with high quality, silicon steel structure to prevent "aging". Coils are heavy duty Nylclad wire, glass taped and sealed for long life. Shading coils are silver soldered for durability and quiet hold and Decco's new "quick change" patented feature affords fast, simple, thirty second coil change, when necessary.

If you have an application for a quality-built, miniature solenoid that will stand up under heavy industrial use, it will be worth your while to investigate Decco's 01 and 02 series miniatures.

Decco SOLENOIDS THE HEART OF DEPENDABLE AUTOMATION EQUIPMENT

DETROIT COIL COMPANY

2435 HILTON ROAD, FERNDALE 20, MICHIGAN

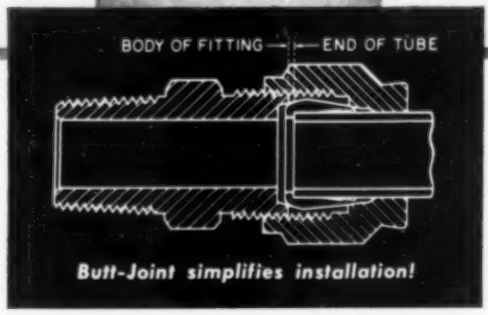
IMPERIAL HI-SEAL BUTT-JOINT FITTINGS

now available in brass, steel and stainless steel

- No flaring or threading
- Withstands higher pressures
- No need to spring tubing
- Permits closer tube bends
- Fast, foolproof assembly
- Meets J.I.C. and A.S.M.E. standards . . . Listed by UL

Tremendous popularity of steel and stainless steel Hi-Seal fittings has led many users to request Hi-Seal fittings in brass. You wanted them—Imperial made them — new brass Hi-Seal fittings . . . plus steel and stainless steel fittings so you can profit from famous Hi-Seal advantages . . . like butt-joint, close bends, quick assembly in the metal best suited to each application.

Tube doesn't enter the body of the fitting. It bottoms on shoulder of the sleeve. Camming action of the nut causes sleeve to form a collet-type triple-seal grip on the tubing.



Final circumferential seal is made by tapered edge of sleeve. No tube torqueing when making a joint. Can be disconnected and reconnected as often as desired.

Write for Bulletin 3061 and complete facts.

See Your Imperial Distributor

IMPERIAL THE IMPERIAL BRASS MFG. CO.

6300 W. Howard St. • Chicago 48, Ill. • *In Canada:* 18 Hook Ave. • Toronto, Ont. • Dept. AH-98

CIRCLE 71 ON TIME-SAVER CARD

IMPERIAL—offers industry's most complete line of fittings and tools for steel, stainless steel, copper, aluminum and plastic tubing.

FLARELESS TYPE FITTINGS

HI-SEAL
Brass
Steel
Stainless Steel

HI-DUTY
Brass
Aluminum

FLEX
Brass

POLY-FLO
Brass

NYLO-SEAL
Nylon

ERMETO
Steel

COMPRESSION
Brass

FLARED TYPE FITTINGS

37° FLARE
Brass
Steel
Stainless Steel

45° HEAVY DUTY FLARE
Brass

45° FLARE AND INVERTED FLARE
Brass

BRASS PIPE FITTINGS

PRESSURE HOSE AND REUSABLE COUPLINGS

Rubber Covered, Rayon Braid Hose — for low pressures.

Cotton Covered, Single Wire Braid Hose — for medium pressures.

Non-Skive Rubber Covered, Single Wire Braid Hose — for medium pressures.

Rubber Covered, Single Wire Braid Hose — for medium pressures.

Rubber Covered, Double Wire Braid Hose — for high pressures.

FLUID CONTROL AND SHUT-OFF VALVES

Needle Type
Toggle Type
Diaphragm Type
Plug Type
2, 3 and 4-way styles

TUBE WORKING TOOLS

CUTTERS
Tube Cutters
Sawing Vises

FLARING TOOLS
45° Flares
37° Flares
Double Flares

TUBE BENDERS
Lever Type
Gear Type
Spring Type

Reamers
Swaging Tools
Test Plugs and Caps
Refacing Tools

Emblem of Quality

BRIEFS

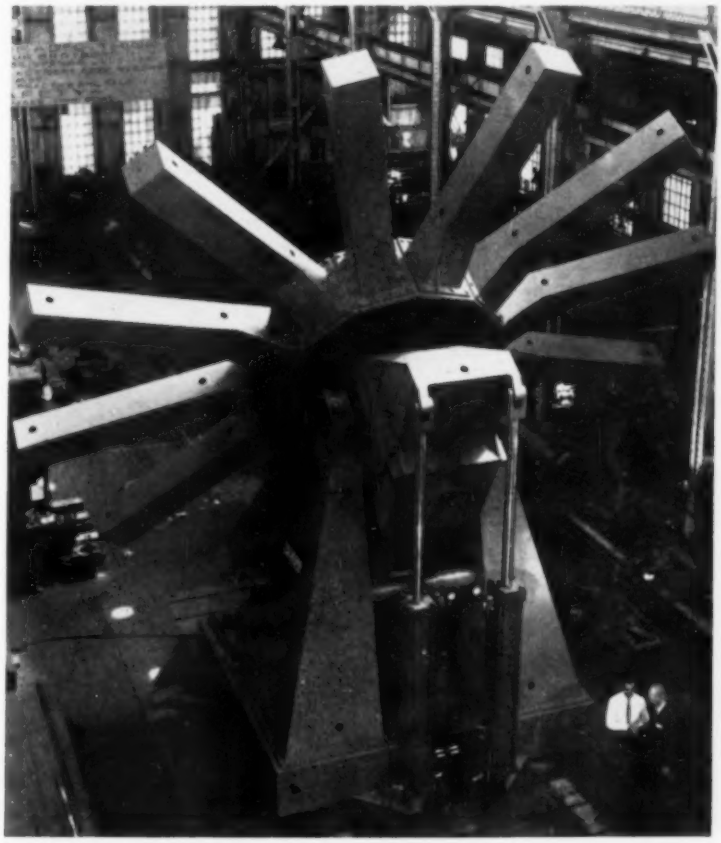
Hydraulic Cylinders Control Weigh-Milling Machine

A milling machine that automatically removes material from large diesel engine pistons in accordance with a precision weight measurement, was designed and built by Snyder Tool & Engineering Co., Detroit, Mich.

The unit consists of two separate machines, one for weighing and one for milling. The weighing machine has a built-in memory device which tells the milling machine how much metal to remove.

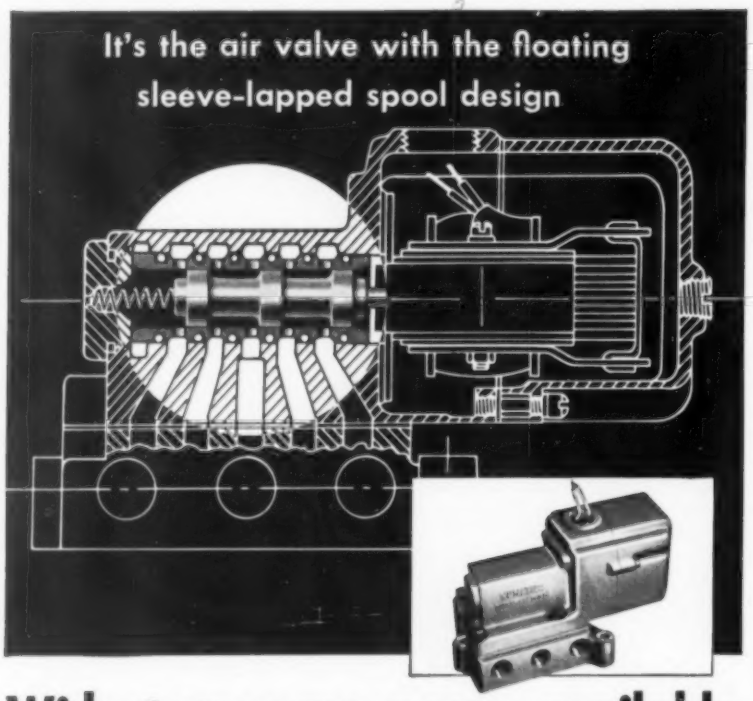
Hydraulic cylinders powered by an external hydraulic pump and tank unit clamp the piston for milling, feed the spindle, and

Continued on next page



HUGE WELDING POSITIONER, weighing 100 tons, has an over-all height of 20 ft. 10 in. Its table has a diameter of 33 ft. A 2000 psi hydraulic system operating the two cylinders shown in the photo tilts the table to any angle up to 60 degrees.

Two electric motors turn the table—a 2 hp motor for slow forward and reverse speeds, and a 7½ hp motor for rapid traverse. The 2 hp motor turns the table at speeds ranging from .005 to .05 rpm; at the lower speed it requires over three hours to make a complete revolution. The unit was designed by the Pandjiris Weldment Co., St. Louis, Missouri.



Widest pressure range available

It's a fact! Numatics air valves operate from 28" Hg vacuum to 300 P.S.I. And this is *standard* with Numatics valves. One valve covers this entire pressure range . . . no external pilot lines, no special springs, no boosters, no extra "gimmicks" of any kind are required. Now, add this important advantage to all the other plus benefits of Numatics valves: *lightning response* . . . 11 milliseconds from energizing to wide open; *consistent action* . . . completely unaffected by pressure fluctuations; *wider speed range* . . . from high cycle welding guns to intermittent and slow-speed automation; *more sizes, solenoids, actions and mountings* than you'll find in any other valve line currently on the market. And what does it all add up to? . . . an air valve that just can't be matched for application, versatility or operational flexibility! Want more details? Write for your catalog today . . . or, better, call your nearby Numatics representative.

You asked for it . . . NUMATICS has come up with it!

LCV CUSHION VALVE

Here it is . . . Numatics amazing LCV. Stops air cylinders without impact . . . allows faster machine cycles . . . reduces material breakage . . . saves wear and tear on machines. Even with heavy loads, the LCV provides controlled deceleration by regulating piston speed with extreme accuracy.

NUMATICS, Inc. HIGHLAND, MICHIGAN

SALES REPRESENTATIVES FROM COAST TO COAST

BRIEFS

make the automatic feed depth adjustment.

Production rate is 261 pieces an hour for aluminum pistons and 192 an hour for cast iron.

When a piston is overweight to an extent that excessive cutter depths would be required to balance it, a light goes on in the control panel and the memory signal is locked out. ▼▼▼

MULTIPLE SPINDLE MACHINE which drills and taps simultaneously has a table which moves up and down hydraulically —rapid traverse up, feed up, feed down, and rapid traverse down. Machine is built by National Automatic Tool Co., Richmond, Ind.

1958 NCIH Plans Are Announced

CHICAGO, ILL.—Twenty-five technical papers will be covered for the some 700 engineers who are expected to attend the 14th annual National Conference on Industrial Hydraulics at Chicago's Sherman Hotel, October 16 and 17.

Raymond D. Meade, Conference secretary, on releasing the preliminary program said, "The successful pattern of earlier conferences is being followed. Sessions are being organized by industry and by product."

Missiles and the role fluid power plays will be the subject of the general session the first

Continued on page 42

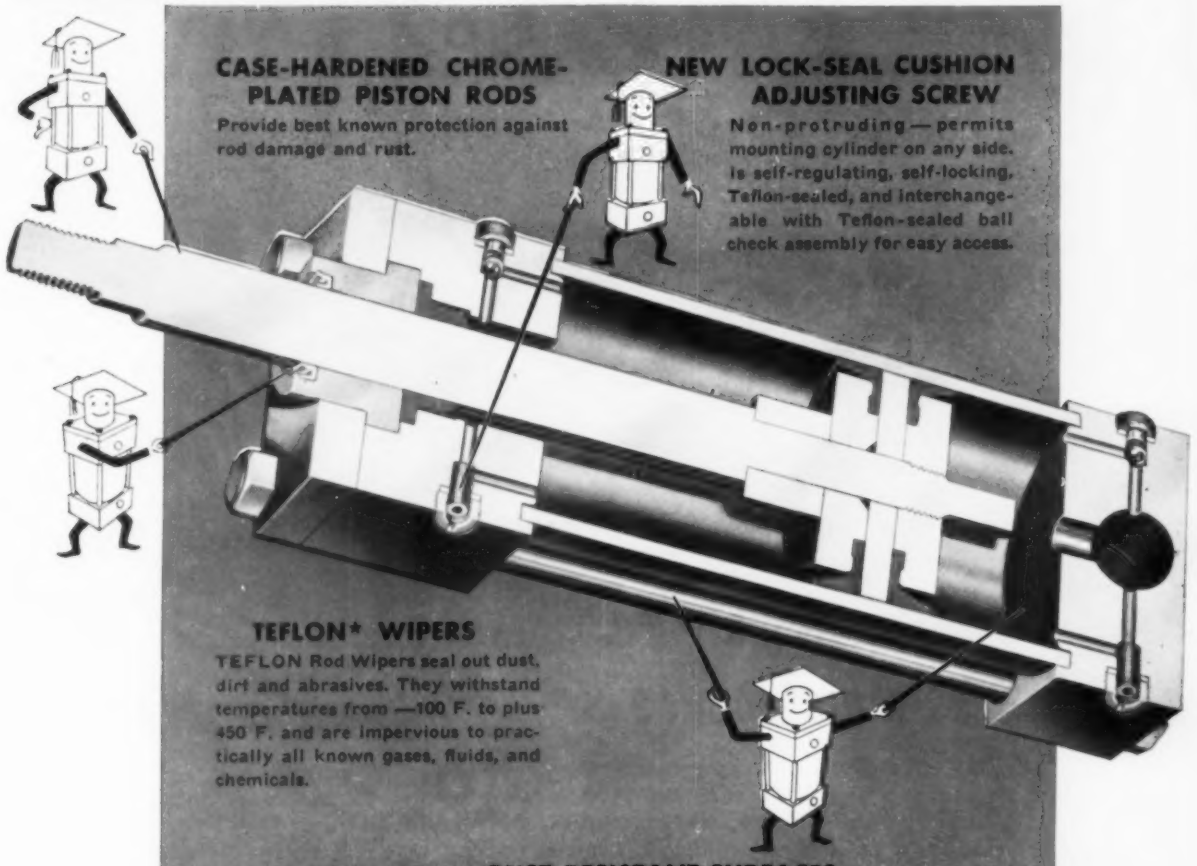
CIRCLE 99 ON TIME-SAVER CARD

CIRCLE 92 →

At No Extra Cost . . .

AIR CYLINDERS

with EXTRA QUALITY Features!



CASE-HARDENED CHROME-PLATED PISTON RODS

Provide best known protection against rod damage and rust.

NEW LOCK-SEAL CUSHION ADJUSTING SCREW

Non-protruding — permits mounting cylinder on any side. Is self-regulating, self-locking, Teflon-sealed, and interchangeable with Teflon-sealed ball check assembly for easy access.

TEFLON* WIPERS

TEFLON Rod Wipers seal out dust, dirt and abrasives. They withstand temperatures from —100 F. to plus 450 F. and are impervious to practically all known gases, fluids, and chemicals.

RUST-RESISTANT SURFACES

Highest Quality Rust-Resistant Coating provides extra protection during shipment, storage, installation, and operation of air cylinders. Cylinder heads, caps, mountings, pistons, followers, and the unplated portions of piston rods have this finish (not recommended for water service).

* duPont trademark for its tetrafluoroethylene resin.

Other Standard Miller Quality Features include: bar stock steel heads, caps, and mountings; rust-resistant brass barrels; self-regulating, wear-compensating piston rod seals that never require adjustment; space-saving square design; and other features as shown in Bulletin A-105 sent free on request.

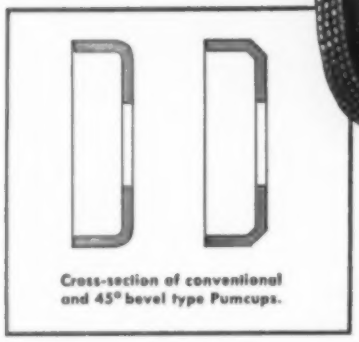
Sales and Service from Coast to Coast . . .

Miller Air Cylinders are available in 1½" through 20" bores for 250 psi operation. Select from 19 standard mountings, strokes up to 22 feet, single and double rod end, cushioned and non-cushioned, and over-size rod cylinders. Large selection for immediate delivery.

MILLER FLUID POWER

2008 N. HAWTHORNE MELROSE PARK, ILL.

2-way gain with Pumcups



Cross-section of conventional and 45° bevel type Pumcups.

Darcova Pumcups are available in various types and textures, in a complete range of sizes, to provide unequalled efficiency and long life in reciprocating pumps, air or hydraulic mechanisms.

★ prolonged high efficiency
★ less maintenance

TODAY hundreds of companies using hydraulic controls, air cylinders or reciprocating pumps are *standardizing* on Darcova Pumcups for piston packing, because they eliminate fluid slippage, costly down-time and maintenance.

Darcova Pumcups make the *most* of the cup packing principle. And, they are made in a complete range of sizes, types and texture-engineered compositions for various pressure-temperature-fluid conditions. Pumcups hold peak efficiency for the life of the cups and outlast other packing as much as 3 to 1.

Why not check these claims right in your own plant? Meanwhile get *all* the facts. Just send for Pumcup Bulletin No. 5503.

DARLING VALVE & MANUFACTURING CO.
Williamsport 15, Pa.

DARCOVA
THE ORIGINAL COMPOSITION CUP

TRADE MARK
PUMCUPS

BRIEFS

morning of the Conference. Speakers will be two top missile-men: commander of an Air Force Missile Test Center, Major General D. N. Yates; and head of Propulsion on the Vanguard project, Kurt Stehling.

There will be four concurrent sessions going on the first afternoon. Men attending the aircraft session will hear talks on the Crusader system and on aircraft component design. At the automotive session two engineers will discuss new automobile suspension systems.

Five men form a panel to give a seminar on hydraulic fluids.

TWO HYDRAULIC cylinders control the heavy duty upper arms of the new 8000 lb capacity, rotating bin dumping attachment for Yale industrial lift trucks.

Two papers at the Press Session will cover standardization and design of a compacting press.

Components, pneumatics and pumps are the subjects of three sessions for the second morning.

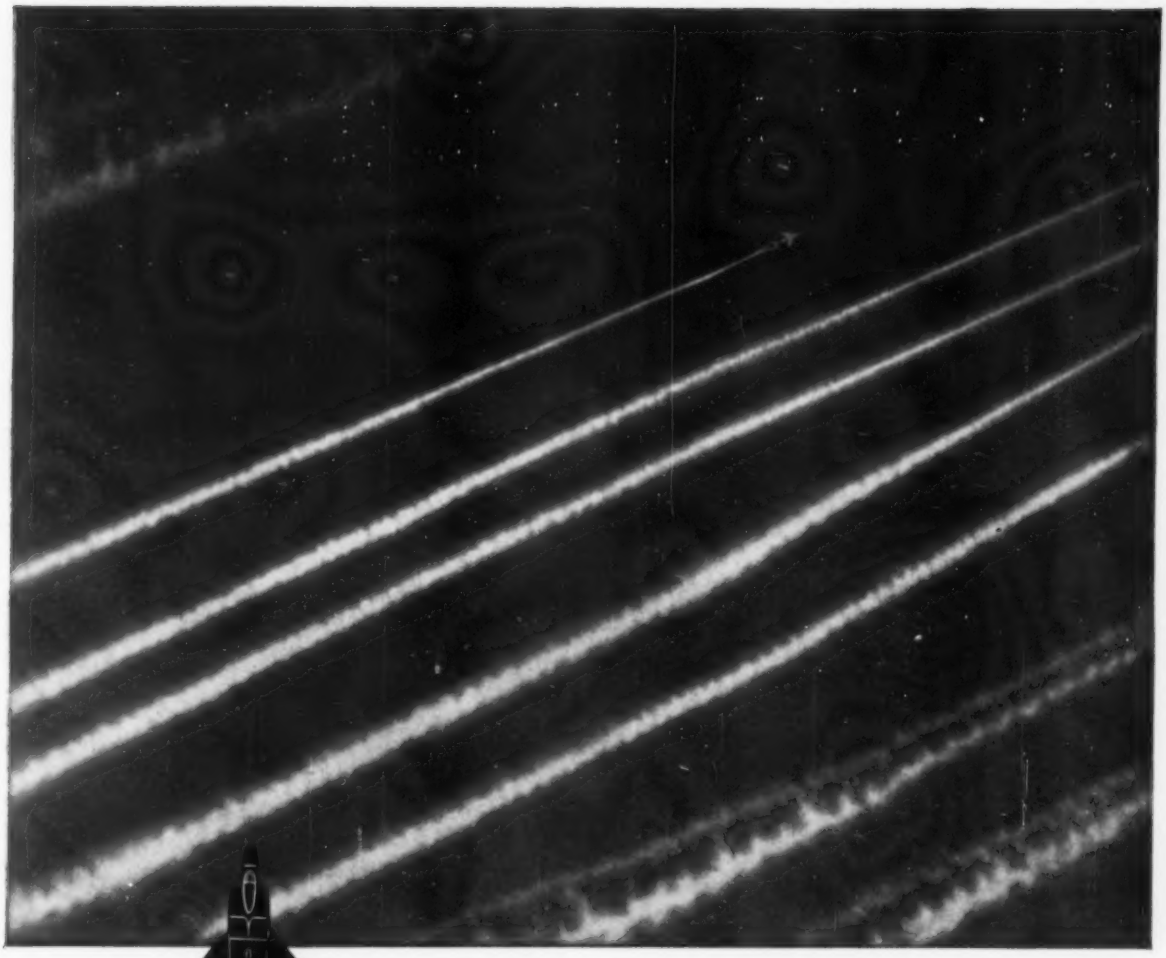
Six papers are scheduled for the final afternoon sessions covering automatic machine tools, mobile equipment and servosystems.

Reservations for the Conference can be made by writing: Conference Secretary, NCIH, 3300 S. Federal, Chicago, Ill. The program includes two luncheons and an All-Engineers banquet, the evening of October 16th.

Final program and abstracts of papers will be published next month in the October issue of APPLIED HYDRAULICS & PNEUMATICS.

▼▼▼

Continued on page 44



Aviation

There are few industries which, for speed of evolution and progress, can be compared with the aircraft industry. The key to this rapid growth has been research, and it is in this field that 'VSG' variable delivery hydraulic pumps and transmission gears have played an important part not only in this country but overseas.

Test rigs of various kinds both for airframe and jet engine development have incorporated 'VSG' equipment as being most suitable for giving that precise control necessary to simulate the required conditions.

This is just another of the highly varied applications of 'VSG' which has now been serving modern industry for fifty years.

'VSG'

Regd Trade Mark

SERVING MODERN INDUSTRY 1908-1958

VICKERS-ARMSTRONGS (ENGINEERS) LTD VICKERS HOUSE BROADWAY LONDON SW1

D27c

H-P-M... a Vital Contributor

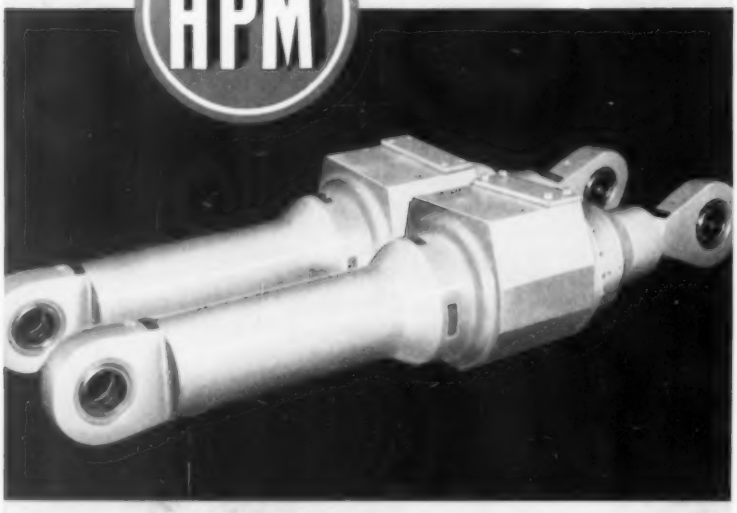
The Hydraulic Press Manufacturing Co. is justly proud of its contribution to our national guided missile program.

The hold-down cylinders, shown below, are typical of the special hydraulic units that H-P-M is manufacturing for use on Ground Support Equipment of this program.

80 years of specialized experience in hydraulics enable H-P-M to meet the exacting requirements of equipment such as this — and to manufacture one of the foremost lines of standard hydraulic components available to industry today.

Our engineering experience is yours for the asking. Write direct to Hydraulic Power Division, H-P-M, Mt. Gilead, Ohio.

HPM



HYDRAULIC POWER DIVISION

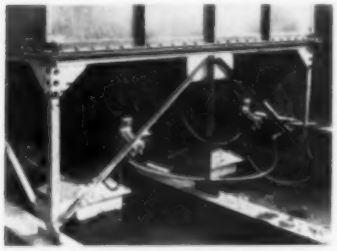
THE HYDRAULIC PRESS MFG. COMPANY

A Division of Koehring Company • **Mount Gilead, Ohio**

BRIEFS

Fluid Powers Human Touch

A Cleveland chemical company recently solved a community relations problem. Their bin vibrators were making too much noise, especially on Sundays when there was little traffic noise. The noise

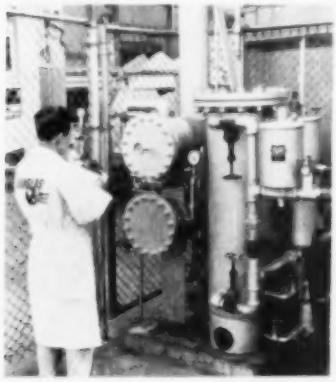


problem was solved by a quiet type air-cushioned vibrator.

The air-cushioned vibrator, made by The Cleveland Vibrator Co., reduces noise by cushioning the vibrator piston's thrust. A small amount of air is released ahead of the piston. This air creates a buffer as the piston moves back and forth, reducing noise to a minimum. ▼▼▼

Air Dryer Increases Efficiency

To assure dry compressed air, required for testing turbines and



precision instruments, Douglas Aircraft Co.'s El Segundo Div. has installed an industrial air dryer at its Torrance, Calif. plant. Made by T. Melsheimer Co. the

Continued on page 48

CIRCLE 68 ON TIME-SAVER CARD

CIRCLE 107 ⟶

"TOMORROW'S"

ENGINEERS WILL SOLVE

SPACE AND SEALING PROBLEMS

WITH PARCO O-RINGS

Parco salutes today's American engineers for their peace-preserving missile achievements! Just as Parco O-Rings and rubber technology are indispensable for today's critical ground and space sealing operations, Parco's Engineering Division will have the answers to tomorrow's problems. Parco will continue to pioneer new O-Ring developments just as it has since the first use of this type of seal. Refer to your local phone book and call your Parco Engineering Representative ... whether you need custom-molded seals for challenging pressure and temperature ranges or prompt delivery from inventory, you do need Parco quality. Write today for your free copy of the new Parco O-Ring Technical Data Reference Log #1581. Also now available, free: O-Ring Ordering Kit #1583 (A) for Commercial O-Rings and #1583 (B) for Military O-Rings.

Parco

PARCO PLASTIC AND RUBBER PRODUCTS COMPANY, 2100 HYDE PARK BLVD., LOS ANGELES 47, CALIF.

Specify J&L
SPECIAL SMOOTH I.D.
"ELECTRICWELD" TUBING
for
- superior surface finish
- exact tolerances
- reduced machining operations

This profilometer test is part of J&L's rigid quality control from ore to finished tubing.

SPECIAL SMOOTH I.D. ELECTRICWELD TUBING

now available with wall thickness to 3/16"

Investigate the possibility of cutting your production costs, improving your products, with this new J&L tubing. The expansion of size range of special smooth Electricweld tubing now permits greater design application of this versatile product. The new wall thickness is made in tubing with inside diameters up to and including 3½ inches.

Special smooth Electricweld tubing has an inside finish superior to most honed surfaces. The mirror-like surface results from J&L's unique drawn-over-mandrel processing method. This eliminates many machining operations and cuts costs in production of hydraulic and pressure cylinders.

For complete information, call your local distributor, or write direct to Jones & Laughlin Steel Corporation, 3 Gateway Center, Pittsburgh 30, Pennsylvania.

J&L STEEL

Jones & Laughlin Steel Corporation

PITTSBURGH, PENNSYLVANIA

DESIGNED FOR HEAVY DUTY BUILT TO TAKE IT!

Every engineering and construction detail of the improved O-M Tie-rod Hydraulic Cylinder adds to its overall operating efficiency under heavy work loads, assuring maximum smooth performance with minimum maintenance. It is ruggedly constructed of heavy walled, seamless steel tubing microhoned to minimize friction. The rolled steel heads are recessed to confine the tube, prevent breathing and to provide additional protection against leakage under the most severe conditions. Heads can be rotated independently at 90° intervals for convenient port location. The piston rod is of stress relieved, high tensile steel, hard chrome plated, turned, ground and polished. The rod gland cartridge that is threaded for quick, easy removal, is accurately piloted in rod head to assure perfect alignment, also serves as pilot for cylinder mounted on rod end. Rod gland contains extra long bronze rod bearing for maximum support of piston rod.

Vee type, non adjustable, self compensating, rod gland packing provides multiple lip seal. Cartridge "O" ring, with leather back up furnishes a positive seal. Rod wiper or interchangeable metallic scraper prevent dirt from entering cylinder on "in" stroke. A complete selection of mounts is available.

These and many other features are described in detail in our latest catalog No. 105. Write for your copy TODAY or consult your local O-M representative.

ORTMAN-MILLER MACHINE COMPANY

1 143rd Street, Hammond, Indiana

☐ Have representative call

☐ Send Bulletin 105

Name_____ Position_____

Company_____

Address_____

City_____ Zone____ State_____

CIRCLE 100 ON TIME-SAVER CARD

Now, at your service

jamesbury

UNIT-BODY

"Double-Seal"™

HIGH-PRESSURE Ball Valves

STYLE H SERIES

. . . outstanding design newly available to industry

for
- High-Pressure service
- High-Vacuum service
- Handling of hazardous fluids
- Cryogenic operations

. . . no other valve has these outstanding features

- Unit-body construction
- Positively leakproof
- Full-flow capacity
- Indestructible in service
- Corrosion-resistant
- Contamination-proof
- Incomparable size-rating-test-burst performance ratio

—a newly developed and advanced valve design with broad industrial applications, available in eight sizes through 2", with 303 and 316 Stainless Steel or Carbon Steel bodies. Choice of nylon or "Teflon" seats and seals.

Distributors in principal cities.

For further information, write: Data: Style "H" Series

225-8

JAMESBURY CORP., 85 NEW STREET, WORCESTER, MASS.

CIRCLE 72 ON TIME-SAVER CARD

BRIEFS

dryer removes water vapor from compressed air lines to eliminate condensation in piping systems.

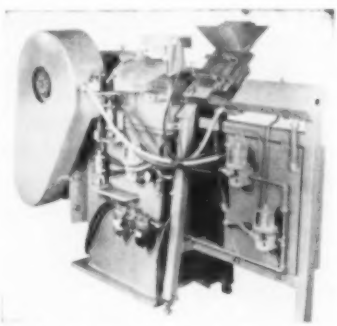
Normal pressure rating is 125 psi. Dewpoint is lowered 40°F below the temperature of air entering the dryer.

Installation of the unit has brought more efficient results and provides the required dry air with a minimum pressure drop. ▼▼▼

PULPWOOD LOADER features a hydraulically controlled self release hook on the split cable. Hook is actuated by a cylinder controlled by a lever near the driver's seat. The attachment is also tilted by hydraulic cylinders. Made by Clark Equipment Co. Battle Creek, Mich.

Air Operated Loader For Tube Flaring Machine

An air operated electrically controlled parts loader and unloader was developed by Automation Associates, Inc., Madison Heights, Mich. for use with their Model B-2 flaring machine.



• **Operation**—Loader has an adjustable steel hopper which holds a supply of tubes. An agita-

Continued on page 50

CIRCLE 143 →

Victor Regulators control high pressure gases...safely and accurately

GD700 SERIES for testing pneumatic components or operating gas systems. Gas-O-Dome primary regulator is controlled by a relief venting, high pressure, spring loaded regulator. This combination offers you precise regulation for both low or high volume applications.

MODEL	PSI MAX. INLET	PSI OUTLET RANGE	GAUGES (integral or panel mounting)
GD710	7000	400-7000	10,000-10,000
GD711	7000	200-3600	10,000- 5,000
GD712	7000	200-2000	10,000- 4,000
GD713	7000	50- 800	10,000- 1,000
GD714	7000	10- 150	10,000- 200
GD700	3600	200-3600	5,000- 5,000
GD701	3600	200-2000	5,000- 4,000
GD702	3600	50- 800	5,000- 1,000
GD703	3600	10- 150	5,000- 200

Flow: Approx. 300 scfm. Leakage: None.
Operating temp. range: −67° F to +200° F (Storage −80° F)

LR SERIES Loading Regulators for "dead end" and low capacity testing (2 sfcm.) of pneumatic components, or for operating gas systems. Will hold dead-end pressures without leakage—also will hold supply pressure even when inlet pressure decreases.

MODEL	PSI MAX. INLET	PSI OUTLET RANGE
LR20B	7000	40-7000
LR19B	7000	20-3600
LR18B	7000	15-2000
LR17B	7000	10- 800
LR16B	7000	5- 200

Operating Temp. Range: −67° F to +200° F (Storage −80° F)
Leakage: None.

BOTH GD700 AND LR SERIES are field proved. They regulate all non-corrosive gases, including oxygen. Forged bronze bodies; stainless steel trim; Kel-F seats; internal filters; built-in adjustable relief. Proof pressure 2 times rated pressure; burst pressure 3 times rated pressure. Panel mounting. Stainless steel models available for corrosive gases. For complete specifications, write us today.

VICTOR for welding

VICTOR EQUIPMENT COMPANY

Mfrs. of welding & cutting equipment; high pressure and large volume gas regulators; hardfacing rods, blasting nozzles; cobalt & tungsten castings; straightline and shape cutting machines.

844 Folsom St., San Francisco 7 • 3821 Santa Fe Avenue, Los Angeles 58 • 1145 E. 76th St., Chicago 19
J. C. Menzies & Co., Wholly-Owned Subsidiary

all STEEL

New Fulflo all-steel, piston type, oil relief hydraulic by-pass valves combine proven features with the advantages of all-steel construction in flange models from 1" to 3".

FULFLO

ALL-STEEL, ALL-BRASS OR OTHER COMBINATIONS FOR POSITIVE AUTOMATIC PRESSURE CONTROL YOU CAN DEPEND UPON AT ALL TIMES

all BRASS

Fulflo Valves feature shear-closing action for quiet, non-chattering operation. They offer greatest safety, matched to job conditions. Priced right for O.E.M. use . . . built right for superior replacement service.

• Standard and flanged models • Just 6 springs for pressures to 500# • Steel, cast iron or brass bodies • Brass, steel or stainless pistons • Pipe sizes to 3"
• Specials to your requirements

COMPLETE CATALOG FREE ON REQUEST

THE FULFLO SPECIALTIES CO., INC.
415 Fancy Avenue, Blanchester, Ohio

FULFLO

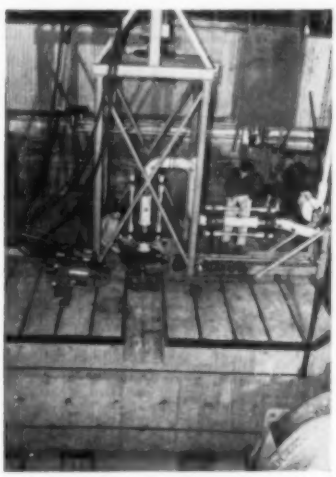
CIRCLE 52 ON TIME-SAVER CARD

BRIEFS

tor feeds tubes into the magazine. The feeder removes the bottom tube from the magazine and feeds it into the open die. The flaring machine clutch is energized and the tube is flared. During the second flaring stroke, the feeder returns to its home position. At the end of the second flaring stroke, the unloader arm reaches into the open die and removes the flared tube with a permanent magnet. Tube is removed from the magnet by a gate through which the magnet can pass but the tube can't. Removal of the tube trips a switch starting the next cycle. ▼▼▼

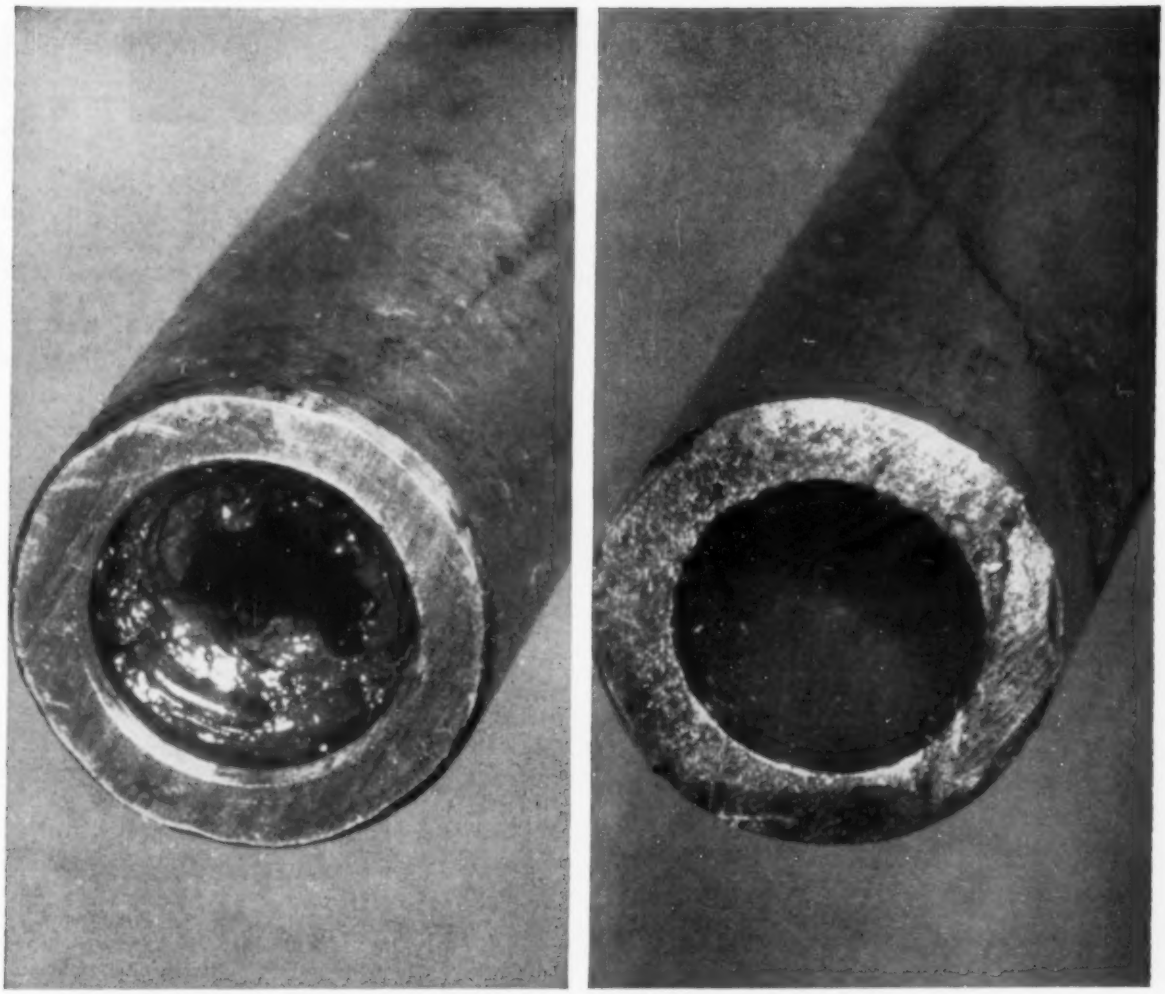
Need A Shake?

You can get it on the most powerful vibration machine recently built by Wyle Associates, El Segundo, Calif., for the USN Engineering Experimental Station at Annapolis.



• **Three Principal Subsystems**—This Hydrashaker, Model W-4500, can meet the Navy's requirement to shake a 3000-lb specimen at 15 G's at 100 cps. The unit consists of the exciter, a 100 hp electric motor-driven hydraulic power supply, and a console containing the electronic system and control panel. The machine utilizes a new principle of electronically controlled hydraulic power. ▼▼▼

Continued on page 52



This sludge-clogged hydraulic line . . . looked like this, after cleaning with a Sunvis 700 oil.

With Sunvis 700 oils, you can clean hydraulic systems and keep them clean

Sludge, caused by high temperatures, and by water, dirt, cutting oils, paint, packing, and by many other contaminants, clogs lines and cuts efficiency.

Sunvis* 700 oils keep these contaminants in suspension, and carry them away to the filters, thereby keeping systems clean and preventing costly shutdowns. In fact, many seriously fouled systems can be cleaned and kept clean permanently by a switch to Sunvis 700 oil. A single charge of Sunvis 700 oil can keep even a continuously contaminated system running smoothly for months, often *years*.

Your Sun man knows Sunvis 700 oils inside out. He has facts, figures, and case histories that prove their quality... quality that means *money in your pocket*. Call him in soon. Or write to Dept. AH-9,

Industrial Products Department

SUN OIL COMPANY, Phila. 3, Pa.

SUNOCO

*TRADEMARK

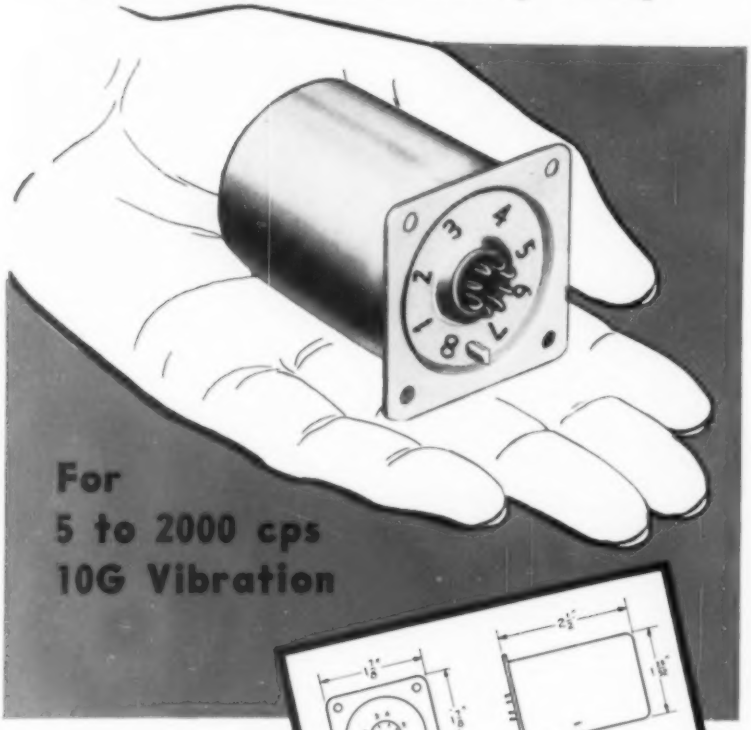
© 1958 SUN OIL COMPANY

In Canada: Sun Oil Company Limited, Toronto and Montreal

CIRCLE 126 ON TIME-SAVER CARD

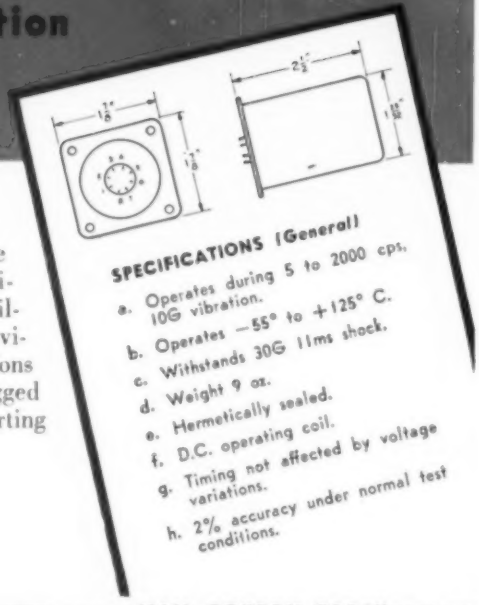
NEW! TYPE AX1

EAGLE D.C. time delay relay



For
5 to 2000 cps
10G Vibration

Uses new type escapement principle. Utmost reliability under severe environmental conditions is insured by its rugged design and self-starting characteristics.



SPECIFICATIONS (General)

a. Operates during 5 to 2000 cps, 10G vibration.
b. Operates −55° to +125° C.
c. Withstands 30G 11ms shock.
d. Weight 9 oz.
e. Hermetically sealed.
f. D.C. operating coil.
g. Timing not affected by voltage variations.
h. 2% accuracy under normal test conditions.

EAGLE
SIGNAL CORPORATION
INDUSTRIAL TIMERS DIVISION
MOLINE, ILLINOIS
Eagle timers save time . . . save money

MAIL COUPON TODAY

EAGLE SIGNAL CORPORATION
Industrial Timers Division, Dept. AH-958
MOLINE, ILLINOIS

Please send Bulletin 820 containing complete data on AX1 Time Delay Relay.

NAME AND TITLE

COMPANY

ADDRESS

CITY ZONE STATE

BRIEFS

Satellite Antenna Tracks Hydraulically

A contract for making the hydraulic drive and control system for an 85 ft. dia. space vehicle radio antenna was awarded to The Rucker Co., Oakland, Calif. It will be built at Goldstone Test Station, Camp Irwin, Calif. The

hydraulic drive and control system will be the nerve center of the project—taking signals from data processing equipment—and rotating the antenna as it locates and tracks satellites and lunar vehicles. The highly accurate hydraulic system will operate by remote control and will not be affected by the elements. It is expected to be in operation by the end of this year.

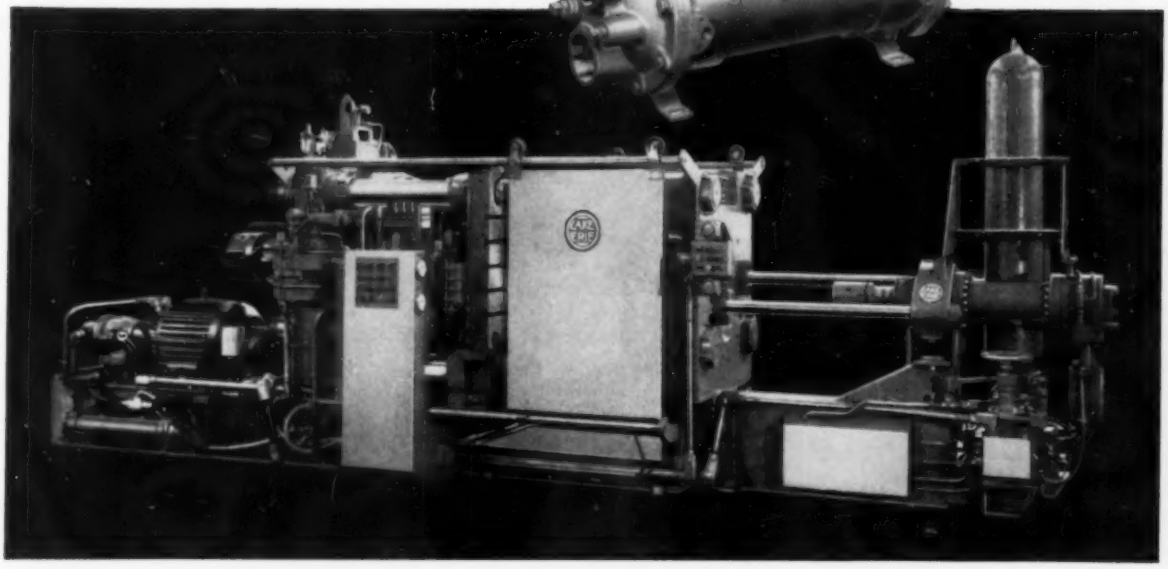
The radio antenna is an initial step in the development of ground equipment needed for the lunar probe program. ▼▼▼

Three hp Circuit Powers 20-Ton Press

This hydraulic press uses a closed shock-free, pressurized hydraulic system with less than 5 gallons of fluid. Rapid cycling is achieved with only a 3 hp motor in the 20 ton, 4-post press. This model has a 12 in stroke,

Continued on page 54

OIL COOLING BY ROSS



"NOTHING BUT SATISFACTORY RESULTS"

SAYS LAKE ERIE MACHINERY CORP.

On this 650-ton Lake Erie Die Caster, as on other types of Lake Erie hydraulic machinery, a Ross Type BCF Exchanger has been factory-installed. By holding hydraulic fluid temperatures in check at all times, it prevents pump slippage from overheated, thinned oil. Full locking tonnage is maintained.

"Aside from our having specified Ross coolers for so many years with nothing but satisfactory results", states Lake Erie Machinery Corp., "we are constantly impressed with other important aspects such as sales engineering. Whether we request confirmation of our cooler selection for a routine application, or whether we require guidance with a complex heat transfer problem, we always receive the same prompt, pleasant attention."

Yes, Ross Exchangers are preferred industry-wide, not only for their high thermal efficiency, but because of the enlightened technical assistance offered by Ross sales engineers. You'll find Ross Coolers featured as "built-in" equipment on engines, lubrication systems and hydraulic machines of every description to cool lube oil, jacket water and hydraulic fluid.

Recently redesigned, rugged, compact Ross Type BCF Exchangers feature *new* flanged-lip baffles for tighter tube fit and improved thermal characteristics, *new* movable feet for easy installation, *new* materials, *new* sizes and capacities in one, two or four pass designs.

Get all the facts. Learn how these pre-engineered, fully standardized units can meet your specific requirements by using coupon below to request *new* Bulletin 1.1K6.

*American-Standard and Standard ® are trademarks of American Radiator & Standard Sanitary Corporation.

AMERICAN-Standard
ROSS HEAT EXCHANGER DIVISION

TO:
American-Standard AH 9
Ross Heat Exchanger Division
Buffalo 5, N. Y.

Please send, without obligation, your new Bulletin 1.1K6 describing the redesigned Ross Type BCF Exchanger.

NAME _____
TITLE _____
COMPANY _____
ADDRESS _____
CITY _____ ZONE _____ STATE _____

highest performance at utility prices!

DECCTO COUPLER

only $4.25 for the highest performing ball-check coupler available.

The "DECCTO" Quick Disconnect Coupler . . .

gives you these advantages:

- Outstanding flow and seal characteristics
- Simple, rugged, dependable locking mechanism
- Easy connecting and disconnecting under pressure
- Positive seal with rapid valve shut-off
- Complete inter-changeability with similar components
- Immediately available from stock

For original equipment or replacement parts on agricultural and industrial equipment, specify Bruning's DECCTO Coupler.

Bruning has a complete line of high performance hydraulic and pneumatic couplers, cylinders and valves.

WRITE FOR FREE BULLETIN NO. 561-1 A.

The BRUNING COMPANY

609 So. 9th St., Lincoln, Nebraska

BRIEFS

10 in. shut height, and a 24 by 30 in. platen.

• **Design**—Compactly designed, all components including the motor, pump and reservoir are mounted on top of the platen. The area beneath is free of equipment allowing use of conveyors. Operator hazards are eliminated by the use of safety-circuit two pushbutton control. Press can be operated as fast or slow as the operation requires. Approach speeds to 2000 ipm are possible. For set-up, the platen can be floated or inched up or down.

• **Uses**—Typical operations of this press include swaging, stamping, shearing, blanking, trimming, forming and drawing. Complete unit is shipped ready for use with the hydraulic fluid sealed in the

reservoir. Press is manufactured by Bausenbach Hydraulics Div., Buffalo Metal Container Corp., Buffalo, N. Y. ▼▼▼

BRIEF NOTES

TUBING FOR 30,000 PSI . . . Pacific Tube Co., Los Angeles, Calif., has installed hydrostatic testing equipment giving hydraulic line proof testing to 30,000 psi. This equipment will be used to test yield strengths of aircraft seamless and welded stainless steel tubing from ¼ to ¾ in. dia and .016 to .065 wall thickness.

SIMPLIFY O-RING ORDERING . . . O-ring manufacturers are adopting the ARP 568 Uniform Dash numbering system. Standard O-rings can be ordered by a common dash number regardless of supplier.

HELP THE FLUID USER . . . E. F. Houghton Co. issued an 8 page brochure on how to install Houghto-Safe water-base 600 Series fire-resistant hydraulic fluid.

FOREIGN SCIENTIFIC LITERATURE . . . which keeps U. S. scientists and engineers informed of progress in other parts of the world, is available on loan to any library in the U. S. from the Midwest Inter-Library Center in Chicago.

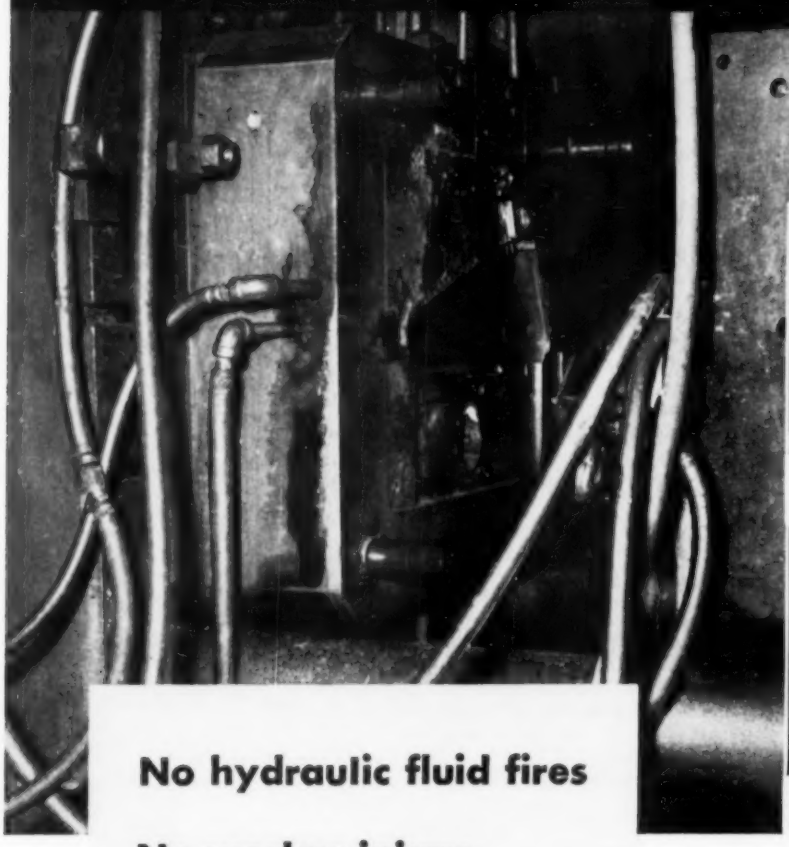
BUSINESS BRIEFS

NEW CORPORATION . . . G. T. Lyon president of L & L Mfg. Co., Van Dyke, Mich., announced forming a new corporation which has purchased Birmingham Hydraulic Products Co. and changed the name to Birmingham Hydraulics, Inc. The firm will continue to manufacture hydraulic panels, drilled manifolds, and side entering subplates.

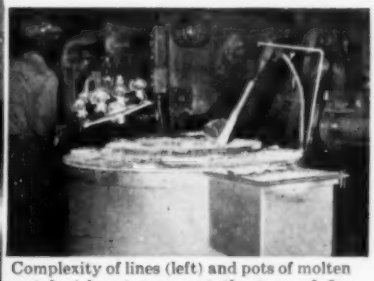
LOWER PRICES . . . C. A. Norgren Co., Englewood, Col., reduced prices 9% on 14 models of its air lubricators. The reduction covers ¼ to 1-in. size and is part of a general price re-adjustment over their entire line.

PATENT ISSUED FOR HOSE FITTING . . . Aeroquip Corp., Jackson, Mich., has been granted U. S. Patent No. 2,833,567 covering its detachable fitting for Teflon hose. Fitting was introduced in 1955.

"For 3 solid years—



Irus Fluid's distinctive yellow color makes it easy to spot and trace leaks.



Complexity of lines (left) and pots of molten metals (above) represent the type of fire hazards requiring Shell Irus Fluid 902.

No hydraulic fluid fires

No worker injury

No equipment damage —since we switched over to SHELL IRUS FLUID 902"

says Ernie Ike, Plant Superintendent
Western Die Casting Co., Emeryville, Calif.

According to Mr. Ike, these results are directly due to the switch-over in 1955 from conventional hydraulic fluids to Shell Irus Fluid 902.

Irus® Fluid 902 is a special combination of petroleum oils mixed with water and emulsifying agents. Its fire resistance is achieved through the relatively high water content. Irus snuffs out fire, *under plant conditions.*

Another important advantage of Irus Fluid 902 is its low cost. Plant operators now using Irus have discovered that Irus Fluid costs up to one-third less than other fire-resistant fluids . . . yet is comparable in performance in every practical respect.

If the hydraulic equipment in your plant is exposed to fire hazards, let a Shell Industrial Representative show you the advantages of Irus Fluid 902. Write Shell Oil Company, 50 West 50th St., New York 20, N. Y. or 100 Bush St., San Francisco 6, Calif.

SHELL IRUS FLUID 902

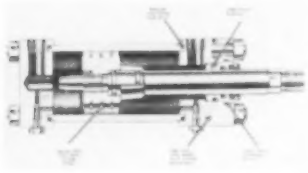
a low-cost, fire-resistant hydraulic fluid

SHELL

NEW PRODUCTS

Components, tools and equipment for fluid power systems. For more information fill in and mail post card bound in this issue.

HYDRAULIC CYLINDERS . . . have pressure tightening tube seals



Designation: Powrdraulic

Features: O-ring seals on the outside diameter of tube and is confined between tube and cylinder head. Expansion of tube under pressure squeezes O-ring tightening the seal. Heads are one piece solid steel. Cartridge gland can be removed with standard spanner wrench.

Specifications: Rated at 2000 to 3000 psi non-shock. Meet JIC recommendations. Bores 1½ to 8 in. Ports are large and have dry seal threads.

Hanna Engineering Works
Chicago, Ill.

CIRCLE 300 ON TIME-SAVER CARD

QUICK COUPLING . . . for reciprocating air tools

Designation: IH

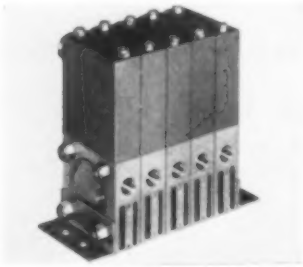
Features: Centerline valve has 360 degree contact with the nipple. Valve opens and closes for the operation of pulsating or reciprocating tools. U packing is used for positive seal.

Specifications: Made with these end connections: male or female pipe, hose shank, AND 10056 male or 10050 female, or AND 10057 bulkhead. Cadmium plated steel ⅛ to ½ in.

Snap-Tite Inc.
Union City, Pa.

CIRCLE 301 ON TIME-SAVER CARD

SOLENOID CONTROL VALVES . . . are streamlined



Designation: S-3C-S

Features: Only one inch thick the wafer type valves can be used separately or manifolded without special parts. Housing is milled from aluminum bar stock. Chambers in the straight through bore are formed with metal spacers which position the O-ring seals. Stainless steel valve plunger is hollow and radially ported.

Specifications: For air or oil to 125 psi and 150 F. Ports are ⅛ or ¼ in. NPT. Rated at 300 cycles per minute continuous, 700 cycles per minute intermittent. Made in normally open or normally closed, 3 or 4-way. Solenoid is mounted with O-rings and a spring to absorb shock. Line pressure passes through each valve. Eight valves can be operated from one line or 16 from two supply lines.

C. B. Hunt & Son, Inc.
Salem, Ohio

CIRCLE 302 ON TIME-SAVER CARD

OIL FILTER . . . offers 3 grades of filtration

Designation: AF-500-X

Features: Pleated paper cartridges have 3000 sq in filtering area. Made in 5, 15, or 35 micron size. Cartridges are interchangeable and throwaway type. Color coded for degree of filtration. Orange, 5 micron; green, 15 micron, and blue, 35 micron. Can be changed without removing piping. The 1 inch inlet and outlet can be at the top or bottom.

General Filters Inc.
Novi, Mich.

CIRCLE 303 ON TIME-SAVER CARD

Continued on page 58

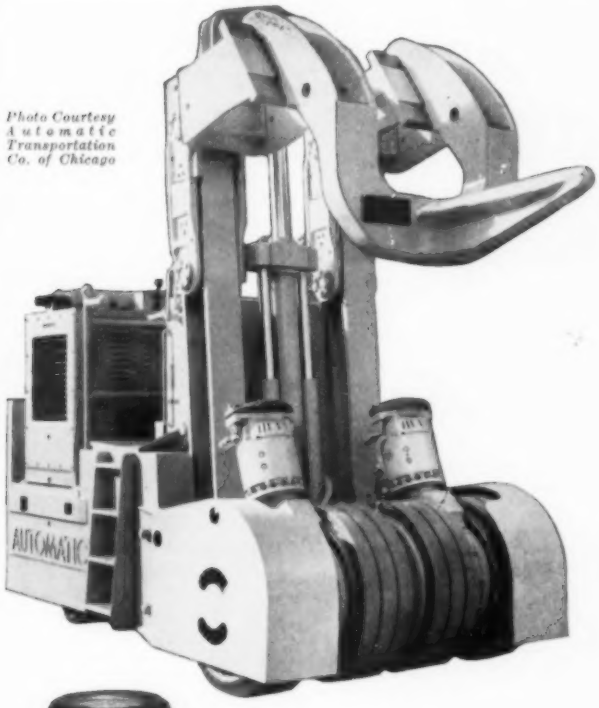


Photo Courtesy Automatic Transportation Co. of Chicago

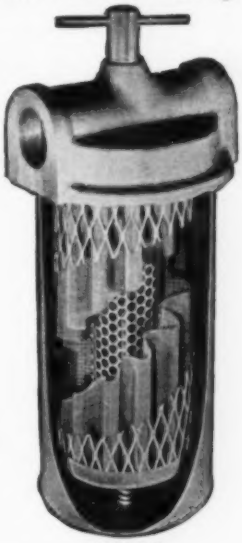
MARVEL SYNCLINAL FILTERS

are Standard Equipment on

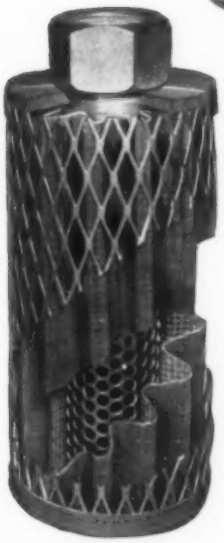
GIANT SKYLIFT Model HR-250

by Automatic Transportation Co. of Chicago

Capable of lifting a 25,000 pound load. It is especially designed to haul coils in steel mills. Marvel Synclinal Filters are installed as standard equipment.



LINE TYPE
(Cutaway)



SUMP TYPE
(Cutaway)

OVER 800
Original Equipment Manufacturers

are installing Marvel Synclinal Filters for dependable protection on machinery, mobile or stationary, utilizing hydraulic and other low pressure circulating systems.

Marvel's BALANCED Synclinal Design
offers Greater ACTIVE Filtering area plus
Greater STORAGE CAPACITY for filtered out particles
RESULT—LOWER PRESSURE DROP
over prolonged periods of operation.

IMMEDIATE DELIVERY

A SIZE FOR EVERY NEED

Available for sump or line installation in capacities from 5 to 100 G.P.M. Greater capacities may be attained by multiple installation (as described in catalog). Choice of monel mesh sizes range from coarse 30 to fine 200.

EASY TO CLEAN

Both sump and line types are easily disassembled, thoroughly cleaned and reassembled, on the spot, in a matter of minutes. Line type operates in any position and may be serviced without disturbing pipe connections.

IN-LINE FILTER
Handles up to 25 G.P.M. of hydraulic oil at very low pressure drop. Monel wire cloth filtering media in mesh sizes from 30 to 100. Cartridge is easily removed for cleaning.

Catalogs contain dimensional charts and complete engineering data making it easy to order a filter for your specific requirements and get Immediate Delivery.

For further information, write, wire, phone or use coupon below.

MEET J.I.C. STANDARDS

MARVEL ENGINEERING COMPANY
7227 N. HAMLIN AVE.,
CHICAGO 45, ILLINOIS
Phone: JUNIPER 8-6023

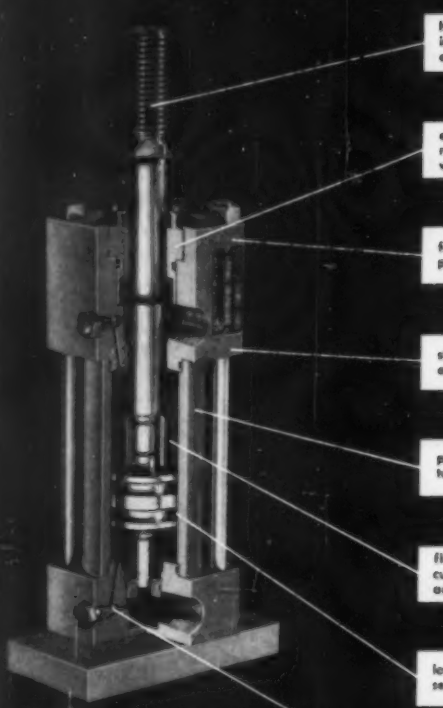
Without obligation, please send me complete data on Marvel Filters, as indicated: AH-Y

- ☐ Catalog #108—For Hydraulic Oils, Coolants, Lubricants
- ☐ Catalog #200—For Fire-resistant Hydraulic Fluids (Aqueous Base)
- ☐ Catalog #400—For Fire-resistant Hydraulic Fluids (Synthetic)
- ☐ Catalog #301—For Water

Name _____ Title _____
Company _____
Address _____
City _____ State _____

for performance...
dependability...
economy... specify S-P

HEAVY DUTY AIR and HYDRAULIC CYLINDERS


hardened oversize rod—maximum rigidity—resists scoring and nicking
easily removed cartridge-type rod seal with integral rod wiper
ferrous parts rust-proofed to prevent corrosion
steel end plates for strength and positive alignment
precision-honed seamless steel tube
floating cushions—uniform cushioning—long life—fully adjustable
low-friction block-vee piston seals or piston rings optional
springless ball checks for faster action

Rated 200 psi air or 1,000 psi hydraulic—interchangeable air or hydraulic without modification—built to JIC standards—specified by automotive manufacturers—conforms to Ford and Chrysler standards.

If your service requirements are severe . . . if you need uniform operation, long trouble-free life, minimum equipment downtime . . . you need S-P *heavy-duty* air and hydraulic cylinders!

Want more proof? A phone call will bring our representative on the run! Prompt deliveries, too. The S-P Manufacturing Corporation, 30201 Aurora Road, Solon, Ohio.

S-P *for speed and performance*

Representatives in principal cities.
Phone or write for Catalog No. 115.

Find us fast in the "Yellow Pages"

NON-ROTATING AIR AND HYDRAULIC CYLINDERS • ROTATING AIR AND HYDRAULIC CYLINDERS • POWER CHUCKS • COLLET AND DRILL PRESS CHUCKS • VALVES, ACCESSORIES

A BASSETT COMPANY • IN GREATER CLEVELAND • ESTABLISHED 1916

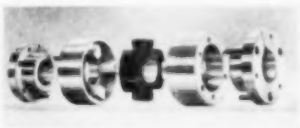
AA-7488

CIRCLE 118 ON TIME-SAVER CARD

NEW PRODUCTS

FLEXIBLE COUPLINGS . . . made of magnesium

Features: Strength of steel with 80% less weight. Lower weight reduces vibration. Simple installation. Coupling halves are slipped on shafts and made vise-tight with



split hubs. Hubs have a taper on the diameter. Machine screws pull the hubs into coupling halves and the taper compresses them on the shaft. Drive is transmitted through a lugged Neoprene insert which insulates and absorbs shock. Made for ¾ to 6 inch shafts.

Detroit Power Coupling Co.
Detroit, Mich.

CIRCLE 304 ON TIME-SAVER CARD

AIR COMPRESSOR . . . for 175 psi

Designation: 25S2

Features: Balanced design reduces vibration and wear. Two-stage, air-cooled, electric motor driven. Each first stage cylinder has individual intake filters. Forced feed lubri-

cation by plunger type oil pump. Can be operated for start-and-stop duty or continuous operation with the cylinders unloading at the set pressure.

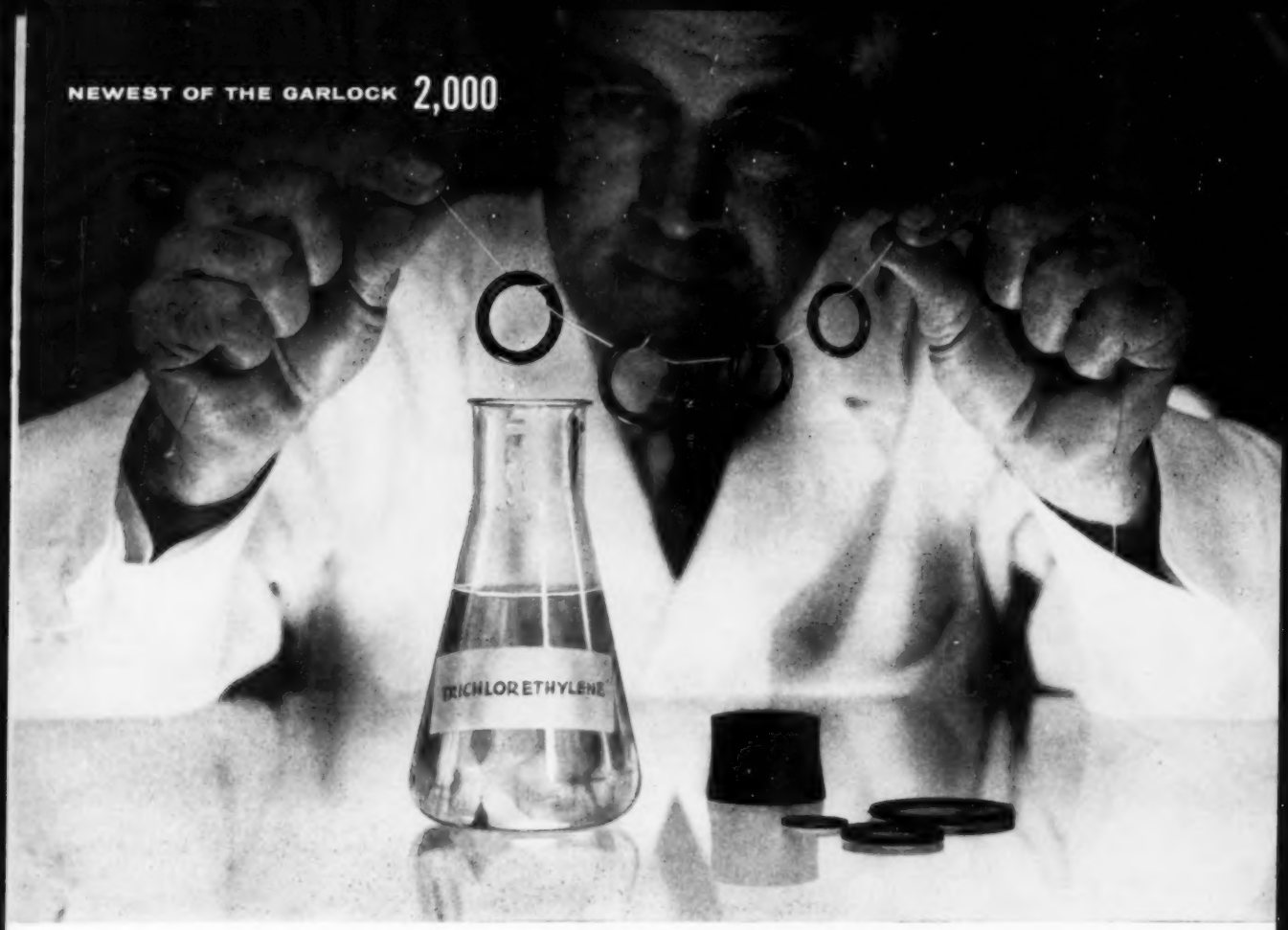
Specifications: Displacement 120 cfm at 175 psi and 870 rpm, and 133 cfm at 125 psi and 960 rpm. Driven by 25-hp electric motor. Size 60½ x 37 x 42 in. Weight 1810 lb.

Le Roi Division
Westinghouse Air Brake Co.
Milwaukee, Wis.

CIRCLE 305 ON TIME-SAVER CARD

Continued on page 60

CIRCLE 55 →



New Garlock Viton* Rubber Parts Offer You Low Swell in Solvents, Resistance to 600°F.

LOW SWELL, GOOD TENSILE STRENGTH DESPITE HEAT, SOLVENTS. Today's era of tremendous horsepower dictates that rubber be able to withstand not only corrosive fluids alone—nor high temperatures alone—but a combination of both. Garlock's new VITON rubber parts do exactly this. It's the only known rubber that will maintain low compression set, low swell, and good tensile strength in contact with most solvents at high temperatures.

IMMERSED FOR SEVEN DAYS. For example, Garlock VITON retains its duro, tensile strength, and elongation characteristics when immersed for one week in twenty of the most widely used—and perhaps harshest—solvents, lubricants, fluids, and acids on the market today. In the test illustrated two O-rings of ordinary Nitrile rubber and two rings of VITON were immersed in trichlorethylene; VITON (right) retained its original dimension—the Nitrile rubber (left) swelled almost 50%.

OVEN AGED AT 600° F. VITON can be oven aged in air at 600° F. for 24 hours, and at 400° F. for 2400. In both cases, it not only retains its excellent mechanical properties, but it remains usefully elastic, proving its value on either intermittent or continuous application.

OPENS MANY NEW USES. Jets and missiles are the more obvious applications for Garlock's new VITON (meets applicable military specifications for military aircraft, etc.). However, VITON is finding important new civilian uses as valve stem seals on truck engines, pump seals on automatic transmissions, and on gasoline pumps, thermostat bellows and domestic washing machines—practically any mechanical equipment where you need rubber parts which give maximum resistance to deterioration by liquid or heat.

VITON is also available as sealing elements in KLOZURE** Oil Seals, flexible members in MECHANIPAK** Mechanical Seals, "O" Rings, Cups, CHEVRON** Packing. VITON products are the newest of the Garlock 2,000 . . . two thousand different styles of packings, gaskets, and seals for every need. The only complete line. See your local Garlock representative, or write for further information.

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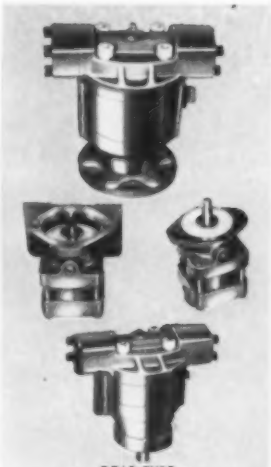
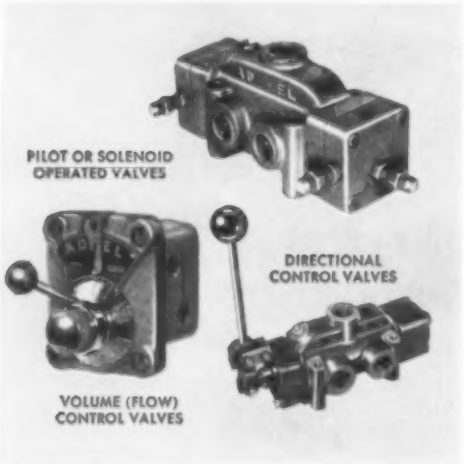


GEAR-TYPE HYDRAULIC PUMPS



ADEL Hydraulics' experience in the design, development and precision production of hydraulic equipment has produced components of unusual reliability, efficiency and economy. These proven Pumps, Motors and Control Valves, available in a wide variety of types, sizes and mountings, may mean new economies in your hydraulic system costs.

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Features: First standard line of filters to be sub-plate mounted. Have pointer which indicates when filter must be cleaned. Two filters

used with a 4-way valve gives continuous filtering with no down time for cleaning.

Specifications: For 3000 psi, full-flow. Made in 10, 20, 30, and 60 gpm with 20, 30, 40, 74, 149, and 238 micron openings.

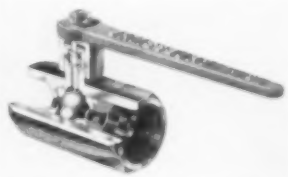
The Rosaen Co.
Hazel Park, Mich.

CIRCLE 306 ON TIME-SAVER CARD

BALL VALVES
. . . for high pressure

Designation: Style H

Features: Unit body construction and quarter-turn, on-off operation. Uses double sealing principle and is leakproof.



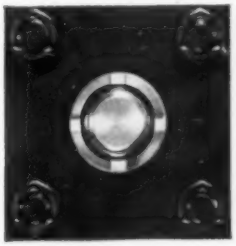
Specifications: Made in ¼ to 1½ in. straight tube threads and ½ to 2 in. pipe threads with carbon steel and 309 or 316 stainless steel bodies. Nylon or Teflon seats and seals.

Jamesbury Corp.
Worcester, Mass.

CIRCLE 307 ON TIME-SAVER CARD

For more NEW PRODUCT reviews turn to page 124

A Message from Parker-Hannifin



Here are the world's finest power cylinders

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This ad is written for the man who has thought all cylinders are "pretty much alike." That just isn't so, and your Hannifin man would like an opportunity to show you why...

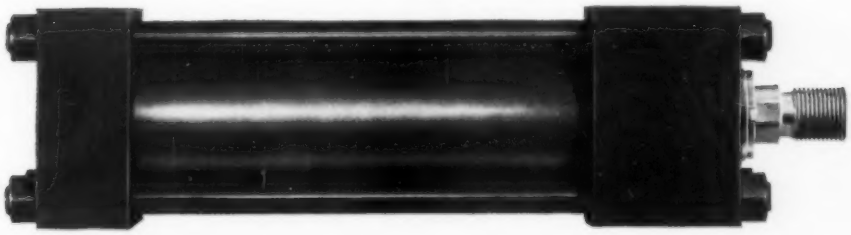
He'll show you design features that other cylinders simply do not have... extra quality workmanship at critical points that pays off in longer life ...accessibility that simplifies their infrequent maintenance. And when he talks price and delivery, you will find these better features cost you no more, can often be delivered sooner.

We think you'll agree that it pays to standardize on Hannifin cylinders.

AIR AND HYDRAULIC

HANNIFIN

POWER CYLINDERS



COMPLETE CYLINDER FILE

Write for your copy of this new Hannifin Cylinder File . . . complete, easy-to-use, easy-to-order-from information on five lines of Hannifin cylinders. Hannifin Company, 545 South Wolf Road, Des Plaines, Illinois.

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USEFUL LITERATURE

For your free copy of publications reviewed, fill in the reader service card

SOLENOID VALVES . . . for liquids and gases to 1200 psi and temperatures to 500 F. A 4-page booklet from *J. D. Gould Co., Indianapolis, Ind.* It illustrates their complete line of bronze valves to 3 in. NPT, and a new line of stainless steel valves to 2 in. NPT.

CIRCLE 400 ON TIME-SAVER CARD

OIL FILTERS . . . with 2-micron ratings for aircraft and missile test stands. A 2-page data sheet available from *Bendix Filter Division, Bendix Aviation Corp., Madison Heights, Mich.* Photographs, cross-section drawings and mounting dimensions.

CIRCLE 401 ON TIME-SAVER CARD

CHECK VALVES . . . for air and liquids at pressures to 400 psi are illustrated in a 4-page bulletin of *The Fairbanks Co., New York, N. Y.* It shows the construction of the swing check and the lift check in bronze and cast iron. Photographs and cutaway drawings.

CIRCLE 402 ON TIME-SAVER CARD

ROTARY AIR MOTOR . . . that develops ⅛ hp is described in a 2-page data sheet published by *Gardner-Denver Co., Quincy, Ill.* Charts and graphs are used to indicate torque, horsepower, and speed. Also included are mounting dimensions and application data.

CIRCLE 403 ON TIME-SAVER CARD

SEAMLESS TUBING . . . for manufacture of cylinders and other hollow parts is the theme of a technical folder published by the *Tubular Products Division of The Babcock & Wilcox Co., Beaver Falls, Pa.* The publication shows how to simplify production with the proper tubing. Included also are industry tolerance tables for cold drawn and hot finished seamless carbon steel mechanical tubing.

CIRCLE 404 ON TIME-SAVER CARD

ENGINEERING DATA . . . fluid motors, pumps, valves, and cylinders are featured in a bulletin by *Commercial Shearing & Stamping Co., Youngstown, Ohio.* Tables and photographs give complete engineering and dimensional data.

CIRCLE 405 ON TIME-SAVER CARD

HYDRAULIC PUMPS . . . air operated. To 25,000 psi from a maximum of 100 psi air are presented in a 6-page folder prepared

by *SC Hydraulic Engineering Corp., Los Angeles, Calif.* It includes all engineering information on the 10-500 series pumps together with application and ordering data.

CIRCLE 406 ON TIME-SAVER CARD

CAP SCREWS . . . that have up to 2 1/3 times the load-carrying capacity of conventional cap screws are described in a bulletin offered by *Standard Pressed Steel Co., Jenkintown, Pa.* The secret of greater strength it says, is in design of the head.

CIRCLE 407 ON TIME-SAVER CARD

VARIABLE DISPLACEMENT PUMPS . . . that save power and reduce heat are featured in a bulletin prepared by *The Oilgear Co., Milwaukee, Wis.* Lists all mounting dimensions and engineering data on the pumps which have capacities to 13½ gpm and pressures to 1100 psi. It also explains how system efficiency is increased by generating only the flow required.

CIRCLE 408 ON TIME-SAVER CARD

ELECTRICAL ENCLOSURES . . . that meet JIC and NEMA Type 12 standards. Catalog issued by *Hoffman Engineering Corp., Anoka, Minn.* Shows complete line of dust and oil-tight wiring boxes, control panel enclosures, control consoles, pushbutton enclosures, and wiring troughs. Loose-leaf, so new sheets can be added.

CIRCLE 409 ON TIME-SAVER CARD

POWER PACK . . . with compact manifolded circuitry for capacities to 5 gpm and pressures to 1000 gpm are shown in a data sheet prepared by *Double A, a Subsidiary of Brown & Sharpe Mfg. Co., Manchester, Mich.* It gives complete details on the units including a diagram of a typical 2-valve circuit. All valves are manifolded directly to the reservoir.

CIRCLE 410 ON TIME-SAVER CARD

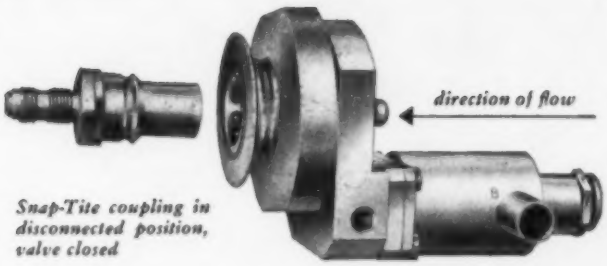
VIBRATION SWITCH . . . to protect motors, pumps and compressors is illustrated in bulletin RF-586 available from *Robertshaw-Fulton Controls Co., Anaheim, Calif.* The model 65 Vibraswitch senses any unusual vibration and trips a switch which can set off an alarm or to shut down the machine equipment.

CIRCLE 411 ON TIME-SAVER CARD

For more reviews of FREE LITERATURE turn to page 153

CIRCLE 124 →

SNAP-TITE REMOTE CONTROL COUPLINGS FOR GUIDED MISSILES



Snap-Tite coupling in disconnected position, valve closed

Here is a specially designed Snap-Tite quick-connect, quick-disconnect coupling, ideal for use in missile-fueling systems. This unit is specifically designed to be manual-connected . . . can also be disconnected manually, or by use of an air-actuated remote control.

NOT A DROP SPILLED!

When the coupling is disconnected, it spills only that small amount of fluid which clings to the metal. The valves in both the coupler and nipple automatically shut off when disconnected, *with no leakage.*

NO AIR INCLUSION!

Coupling operation encloses only a minute amount of air.

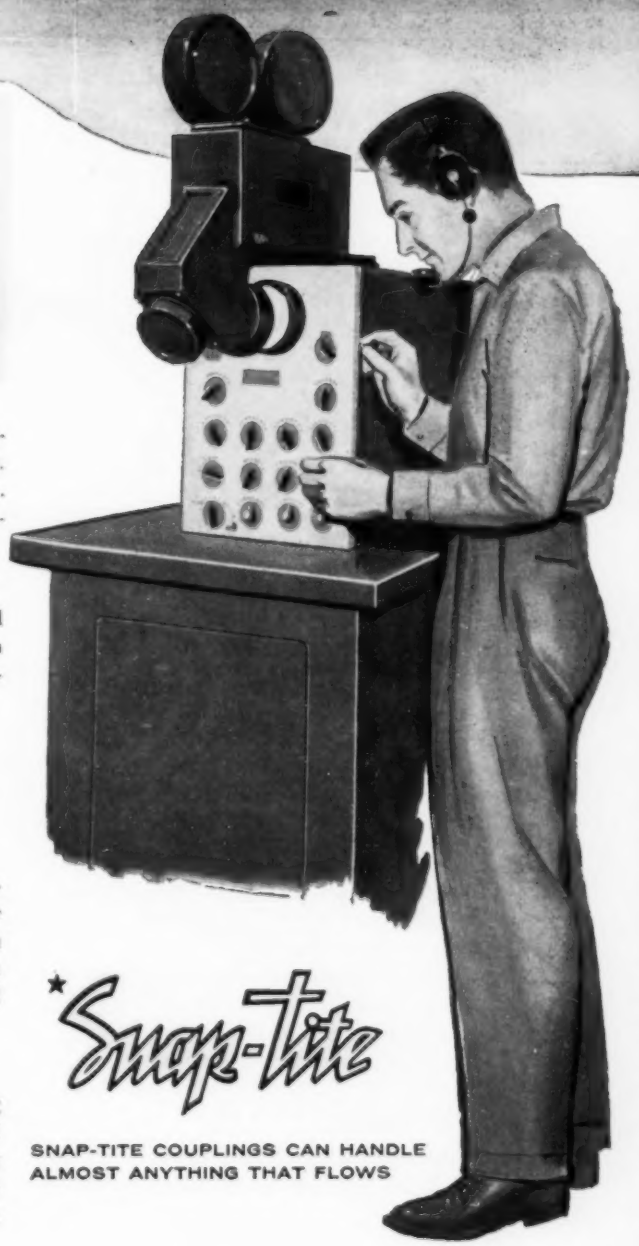
MINIMUM PRESSURE DROP!

Smooth, streamlined passages assure maximum flow.

Variations of this coupling, to meet your required specifications, can be furnished with the appropriate seals to handle liquified gasses, exotic fuels, and a large variety of fluids with working pressures up to 3,000 PSI and temperatures from −300°F to +400°F. Units have been designed up to and including 5″ size.

STANDARD COUPLINGS, TOO!

Your coupling needs might not be as critical as the coupling shown here, but you can be sure, when buying standard Snap-Tite couplings, that the same outstanding engineering and manufacturing skills are basic throughout the Snap-Tite line. Write for complete catalog . . . or describe your specific coupling problems. Snap-Tite, Inc., Union City 1, Pa.



★Snap-Tite

SNAP-TITE COUPLINGS CAN HANDLE ALMOST ANYTHING THAT FLOWS

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When you use Vickers hydraulics, you can send your machinery almost anywhere in the free world with assurance that consistent quality service units will be available.

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NOW...

Reduce Costly Honing Time with Republic ELECTRUNITE Cylinder Tubing

Electric resistance welded steel tubing gives you positive mechanical and fluid-flow advantages which are not available in tubing made by other processes . . . or, from other metals.

Republic offers ELECTRUNITE Hydraulic Cylinder Tubing that has proved itself in a wide range of applications. ELECTRUNITE® is furnished to guaranteed mechanical properties, can be furnished to tolerances that in many cases are satisfactory with no additional sizing, and in a great many cases, the surface finish (as expressed in microinches) is satisfactory for use in cylinders with no further finishing.

When the application requires a honed surface, the honing cost can be reduced as much as 50%, and in many cases the original wall thickness can be substantially reduced.

Call your Republic representative to learn more facts firsthand, or write direct.

MAXIMUM AVERAGE READINGS (Microinch)

Outside Diameter	Wall Thickness		
	0.065 and under	Over 0.065 to 0.150 incl.	Over 0.150 to 0.187 incl.
½ to 2½ in. inclusive	40	45	55
Over 2½ to 4½ in. inclusive	40	50	60

Suggested Procedure

for Making Microinch Readings on Interior Surfaces of Cold Worked Tubing (not Polished or Ground) ½-inch I.D. and Larger.

Section 1. Measurements on tubing with longitudinal or no predominate lay should be circumferential on the inside surface of the straight tube, prior to any fabrication in a plane approximately perpendicular to the tube axis. Measurements on tubing with circumferential lay should be longitudinal.

Section 1-A. Measurements should be made not less than 1 inch from the end.

Section 1-B. Measurements should be made at four positions approximately 90 degrees apart or over a complete circumference if the trace should otherwise overlap.

Section 1-C. The length of trace should be in accordance with Section 4.5 of ASA Standard B46., latest revision. (Not less than 0.600 inch long.)

Section 1-D. A minimum of three such measurements should be made spaced not less than ¼ inch apart along the longitudinal axis.

Section 1-E. The numerical rating shall be the arithmetical average microinch of all readings taken. Each reading to be averaged should be the mean position of the indicator during the trace; any momentary meter excursions occupying less than 10 percent of the total trace should be ignored.

Section 1-F. A deviation in numerical rating in various parts of a tube may be expected. Experience to date indicates that a variation of about plus or minus 35 percent is normal.

Section 2. Instruments should meet the specifications given in ASA Standard B46., latest revision.

Section 3. Mechanical tracing is preferred. If hand tracing is used, the speed of trace should not vary by more than ± 20 percent from that required to give the appropriate cutoff. The 0.030 inch roughness with cutoff should be used.

Section 4. Microinch determinations only refer to roughness of areas that do not contain a defect, injurious or otherwise. Such defects as seams, slivers, pits, laps, etc., are subject to ordinary visual inspection in accordance with applicable specifications or trade customs, and have no relationship to roughness.

REPUBLIC STEEL
STEEL AND TUBES DIVISION

REPUBLIC STEEL

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CIRCLE 113 ON TIME-SAVER CARD

Vogt

DROP FORGED STEEL VALVES and FITTINGS

Modern die casting machine operation involves the use of standard hydraulic oils as well as special non-inflammable oils which must be safely and positively controlled at pressures from 800 pounds up to 4000 pounds per square inch.

Vogt drop forged steel valves, fittings, flanges and unions are unsurpassed for these rigorous duties and are standard equipment on the leading makes of die casting machines.

Consult Catalog F-9 for the complete line of Drop Forged Steel Valves, Fittings and Flanges.

"FIRST CHOICE OF THE LEADING MAKERS OF DIE CASTING MACHINES"

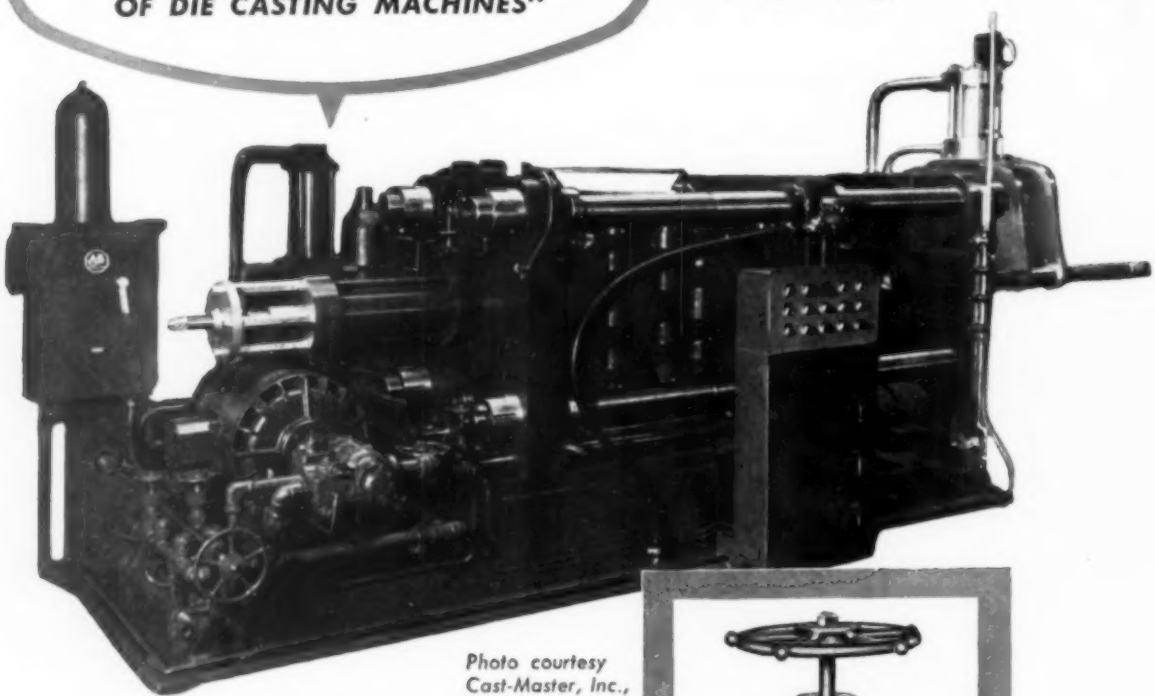

Photo courtesy Cast-Master, Inc., Cleveland, Ohio

HENRY VOGT MACHINE CO.
P.O. Box 1918
Louisville 1, Kentucky

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St. Louis, Charleston, W. Va., Cincinnati

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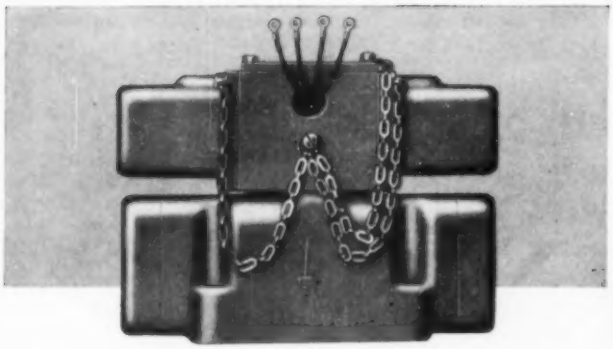

A LOGAN HYDRAULIC CONTROL VALVE

2 competitors' control valves

do they LOOK ALIKE? ...sure they do on the surface...

...BUT LOOK AT Logan's BIG EXTRA PLUS VALUES

Logan Hydraulic Control Valves

are made to interchange with other leading manufacturers' control valves . . .

1. Logan designs assure the service required for those extra-rugged applications.
2. Over FORTY YEARS of fluid power components manufacturing know-how.
3. Built by CRAFTSMEN whose average service record with LOGAN is more than 20 years.
4. Manufactured in a plant which applies the most modern production methods.

FREE

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LOGANSPORT MACHINE CO., INC.
832 CENTER AVENUE, LOGANSPORT, INDIANA

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- ☐ 100-4 AIR VALVES
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- ☐ 200-3 750 SERIES HYD. CYLINDERS
- ☐ 200-4 AND 200-7 HYD. VALVES
- ☐ 200-6 SUPER-MATIC CYLS.
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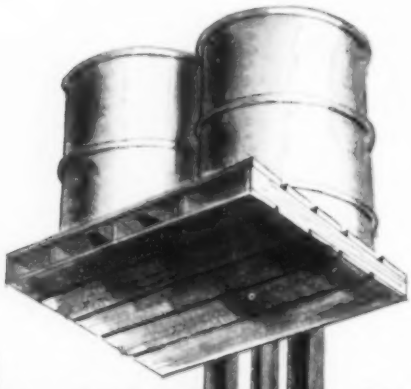
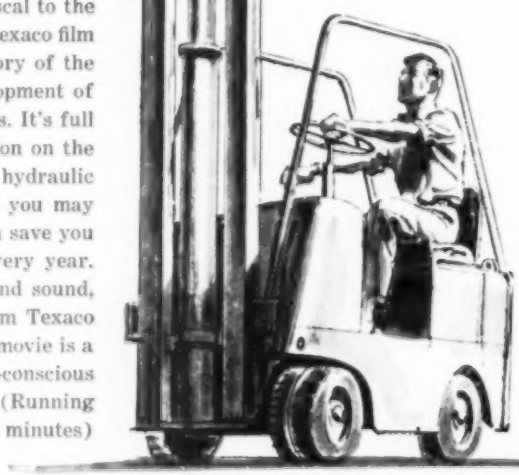
"HYDRAULICS"



From Pascal to the present, this new Texaco film tells the story of the discovery and development of hydraulic principles. It's full of valuable information on the care of your hydraulic equipment – facts you may not know that can save you thousands of dollars every year. Filmed in color and sound, this new 16mm Texaco industrial service movie is a "must" for every cost-conscious plant engineer. (Running time: 25 minutes)



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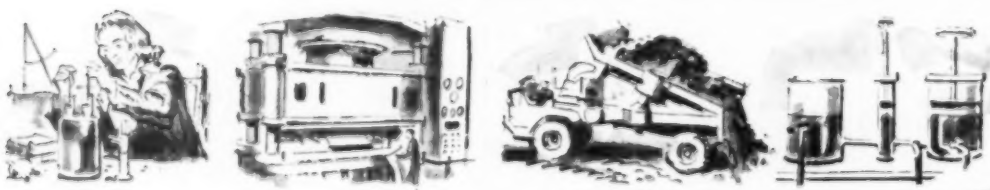
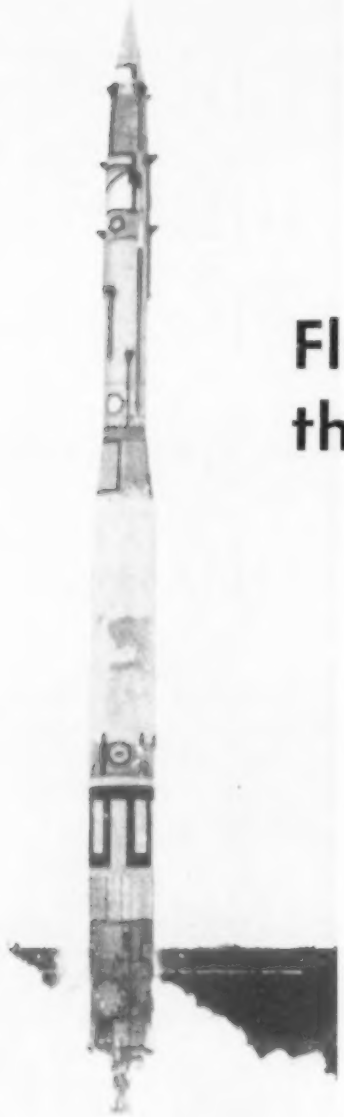


TEXACO

LUBRICATION IS A MAJOR FACTOR IN COST CONTROL

APPLIED **Hydraulics** & **Pneumatics**

SEPTEMBER 1958



Fluid power — the muscles for missiles

ALL the articles in this issue of APPLIED HYDRAULICS & PNEUMATICS are on fluid power applications for missiles and ground support equipment. What's the reason? Because, this mushrooming industry is growing so fast—four billion dollars, about ten times as much as was spent in 1955, will be spent in 1959 on missiles and support equipment—and because fluid power is used on almost every missile and rocket as well as on the support equipment. Incidentally, people in the business think that 50% or even more of this money goes for the support equipment.

Why is fluid power so popular in missile systems? On a guided missile, which is basically an unpiloted aircraft, there's no better substitute for the muscles of a pilot. On the ground equipment, it's because heavy loads must be handled fast and accurately.

What is done with fluid power on missiles? Power steering—actuation of the directional controls—is done almost 100% with hydraulic servos on those missiles using in-flight controls. The hydraulic actuators may move rudders, elevators, and ailerons as used on airplanes or they may move a gimballed rocket engine to change direction of thrust and thus the flight path. Where turbojet and ramjet engines are used, fluid power may be used to position fuel control valves, change air inlet geometry, and control exhaust nozzle area. Control of fuel flow to liquid-fuelled rocket engines is another application.

On the ground, fluid power helps assemble missiles at launching sites, lifts them to the right launching angle, and aims them in the right direction. Power steering of the trucks used to transport the missiles is also a common application of hydraulics in ground support. Ground checkout equipment, portable or semiportable hydraulic and pneumatic power supplies are other important pieces of the picture. The hydraulic power supplies let all parts of the missile hydraulic system be checked for proper operation without using the missile's pump or other source of hydraulic pressure. Pneumatic supplies are used the same way and also to charge air bottles on the missile. Perhaps the most unusual pieces of ground support equipment using fluid power are the motion simulators, or missile exercisers, used to put a missile through its paces without leaving the ground.

• **Missile Types**—Although there are many different missiles, they all fall into one of four major categories. These are: 1. Air-to-Air, 2. Air-to-Ground, 3. Surface-to-Air, 4. Surface-to-Surface. The table on the following pages lists the missiles in these groups using fluid power either on the missile or for ground support. It gives a pretty good idea of the widespread use of fluid power in this field.

CHECKLIST OF HYDRAULICS AND PNEUMATICS ON MISSILES AND GROUND SUPPORT

Missile Name and Class	Service Branch	Missile Status	Range (miles)	—Hydraulics Used For— Flight Control	Engine Control	Ground Support	—Pneumatics Used For— Flight Control	Engine Control	Ground Support
AIR-TO-AIR									
Diamondback	Navy	Development	N.A.	X	---	---	---	---	---
Falcon	Air Force	In Service	5	X	---	X	---	---	---
Genie	Air Force	In Service	1.5	X	---	X	---	---	---
Sidewinder*	Navy	In Service	6-7	---	---	X	X	---	---
Sparrow I*	Navy	In Service	5	X	---	---	---	---	---
Sparrow II	Navy	Production	5	X	---	X	---	---	---
Sparrow III	Navy	Development	5-8	X	---	X	---	---	---
AIR-TO-SURFACE									
Bullpup	Navy	Production	5	X	---	X	---	---	---
Corvus	Navy	Development	N.A.	X	---	X	---	---	---
Crossbow	Air Force	Development	N.A.	X	---	X	X	---	---
Dove	Navy	Cancelled	N.A.	---	---	---	X	---	---
Green Quail	Air Force	Development	N.A.	X	---	---	---	---	---
Hound Dog	Air Force	Development	N.A.	X	---	X	---	---	---
Rascal**	Air Force	In Service	100	X	---	X	---	---	---
Wagtail	Air Force	Development	N.A.	X	---	---	---	---	---
ANTI-SUB									
Asroc	Navy	.....	N.A.	X	---	X	---	---	---
Astor	Navy	.....	N.A.	X	---	X	---	---	---
Petrel	Navy	In Service	50	X	---	---	---	---	---
Rat*	Navy	Production	5	X	---	---	---	---	---
Subroc	Navy	.....	N.A.	X	---	X	---	---	---
SURFACE-TO-AIR									
Bomarc**	Air Force	Production	200-250	X	X	X	---	X	X
Bull Goose	Air Force	Production	2,000+	X	---	X	---	---	---
Hawk I	Army	Production	22	X	---	X	---	---	---
Nike-Ajax*	Army	In Service	35	X	---	X	X	X	X
Nike-Hercules	Army	Production	75	X	---	X	---	---	X
Nike-Zeus	Army	Development	N.A.	X	---	X	---	---	---
Talos*	Navy	Production	70	X	X	X	X	X	X
Tartar*	Navy	In Service	N.A.	X	---	X	---	---	---

Tartar*	Navy	In Service	N.A.	X	---	X	---	---	---
Terrier I*	Navy	In Service	10	X	---	X	---	---	---
Terrier II*	Navy	Production	20	X	---	X	---	---	---
SURFACE-TO-SURFACE									
Atlas*	Air Force	Production	5,500-6,200	X	X	X	---	X	X
Corporal	Army	Production	100	---	---	X	X	X	X
Dart	Army	Production	1	X	---	---	---	---	---
Honest John	Army	In Service	18-20	---	---	X	---	---	---
Jupiter*	Army	Production	1,500-2,000	X	---	X	X	X	X
Lacrosse*	Army	Production	20	X	---	X	---	---	---
Little John	Army	Production	10	---	---	X	---	---	X
Mace*	Air Force	Production	700	X	X	X	X	X	X
Matador*	Air Force	In Service	700	X	X	X	X	X	X
Polaris*	Navy	Development	1,500	X	---	X	---	---	X
Redstone*	Army	In Service	180-250	X	---	X	X	X	X
Regulus I	Navy	In Service	500	X	---	X	X	---	X
Regulus II	Navy	Production	1000	X	---	X	X	---	X
Sergeant	Army	Production	100+	---	---	X	---	---	---
Snark	Air Force	Production	5,000-6,500	X	---	X	---	---	---
Thor*	Air Force	Production	1,500-2,200	X	---	X	X	---	---
Titan*	Air Force	Development	5,500	X	---	X	---	---	X
TEST MISSILES									
Arcon*	Navy	.....		---	---	X	---	---	---
Cherokee	Air Force	.....		X	---	---	---	---	---
Skokie	Air Force	.....		X	---	---	---	---	---
Vanguard	Navy	.....		X	---	X	---	---	---
X-7	.....	.....		X	---	---	---	---	---
DRONES									
Q-2	Air Force	In Service		---	---	X	---	---	---
Q-4A	Air Force	Development		X	---	---	X	---	---
Q-5	Air Force	Development		---	---	X	---	---	X
RP-76	Army	Development		---	---	X	---	---	X
SD-3	Army	.....		X	---	X	X	---	---
Swallow	Army	.....		---	---	X	X	---	---

*Articles detailing fluid power systems for these missiles and/or ground support equipment are in this issue.
**Design articles prepared for publication in coming issues of APPLIED HYDRAULICS & PNEUMATICS

Centrifugal pumps match harmonic flow ar
. . . design of ship motion simulator to

• By L. Mollick, *Project Engineer*
Loewy-Hydropress Division Baldwin-Lima-Hamilton Corporation, New York, New York

Most ballistic missiles are launched from a stable platform, but not the "Polaris." It's launched from a submarine or ship, under conditions which may produce rapid motion.

To learn about launching under these conditions, the Loewy-Hydropress Division of the Baldwin-Lima-Hamilton Corporation has developed and built a ship-motion simulator big enough to accommodate missiles of the Polaris class. The job took two years.

The design and construction of a machine this big, with very severe operating specifications, takes the ingenuity of the mechanical, hydraulic and, particularly, the controls designer. The work of H. Albers and L. Robbins of Loewy-Hydropress was invaluable in the design.

THE servo-controlled simulator duplicates the essential motions of a ship. Other testing which can be done with the equipment includes: handling, servicing, structural integrity, guidance, control, launcher operation, and motion characteristics.

• **Design Parameters**—A ship has six degrees of freedom. The three rotational motions are roll, pitch, and yaw about the lateral, longitudinal, and vertical axes; the three translational motions are sidle, surge, and heave. Only roll, pitch, and heave produce enough displacement, velocity, and acceleration to affect launching.

The actual motion of a ship is purely random. The periods, phases, and amplitudes of possible motions are always changing. However, for a particular ship, certain operating limits can be fixed. The motion is basically periodic; certain amplitudes and frequencies of roll, pitch, and heave will rarely be exceeded; and the motion is nearly harmonic, although never ideally so. To study the missile under conditions which can be controlled and repeated, the simulator hydraulically produces sinusoidal (harmonic) motion.

• **Mechanical Arrangement**—A pair of large diameter, concentric rings are gimbal-mounted, similar to a rate gyro, to permit roll and pitch. The gimbal points correspond to the center of roll and pitch of a vessel. The outer gimbal is supported on a crosshead which moves vertically in guides to give the heave motion.

Test devices are mounted within the 10-ft diameter opening of the simulator. Four hydraulic cylinders support the simulator. Two are controlled by valving and are called *actuating* cylinders. The others are called *balancing* cylinders. Together with an accumulator, they counterbalance part of the weight and save power.

Additional hydraulic cylinders produce roll and pitch. These are in opposing pairs, set at right angles. The pair producing roll acts between the outer gimbal ring and the crosshead. The other pair for pitch acts between the inner gimbal and the crosshead. All four have ball joints at both ends for free motion.

• **Hydraulic Design**—Applying pressure to the opposing cylinders in each pair produces roll and pitch oscillations. Similarly, applying pressure to the vertical actuating cylinders produces upward heave. Downward heave is produced by gravity but controlled by throttling.

Each motion is independent and controlled separately by regulating the inlet flow and pressure to the cylinders during acceleration, and regulating the outlet flow during deceleration. Pressure and flow are controlled by specially designed, electro-hydraulic positioned, throttle valves which are servo controlled.

The heave pump system is separate from the roll-and-

w and pressure
or to test Polaris

pitch pump system in order to minimize hydraulic interaction. Each pump is a centrifugal type which has a drooping pressure-volume characteristic designed for the sinusoidal variation of flow and pressure. The heave pump is rated at 2,250 hp with a peak of 3,000 hp. The roll-and-pitch pump is rated at 700 hp. The hydraulic counterbalance in the heave system saves about 500 hp. The pumps are driven at 6000 rpm by induction motors working through speed increasers.

Water with soluble oil added was selected as the fluid because its lower viscosity permits higher pipe line velocities than oil, with lower friction loss. Thus, valves were kept small, saving valuable space. Water is less compressible than oil and this increases the stability of the system which has rapid changes in pressure. Most important, water eliminates the fire hazard due to high temperatures of the missile exhaust.

• **Heave System**—In the heave system for raising and lowering the test device, pressure water is supplied at a controlled rate to the actuating cylinders only during upstroking. The weight of the system forces it down. This downstroke is closely controlled by throttling flow from the single-acting cylinders. The balancing system supplements the actuating system by retarding motion during the downstroke and aiding it on the upstroke. The balancing system is sized to permit adequate control by the actuating system in both directions. If the balancing cylinders were too large they would accelerate the mass upwards too rapidly and would prevent it from dropping fast enough. If they were too small, the pump would have to be large and do excessive work during the upstroke. On the downstroke the throttling valve would have to waste all the potential energy causing wear within the valve and considerable heat input into the hydraulic circuit.

An actuating accumulator acts as a loading device for the pump. During the downstroke, the pump delivers to the accumulator at a rate that decreases as accumulator pressure rises. Pressure at low water level of the accumulator permits only slightly more than the maximum rated pump discharge (and power).

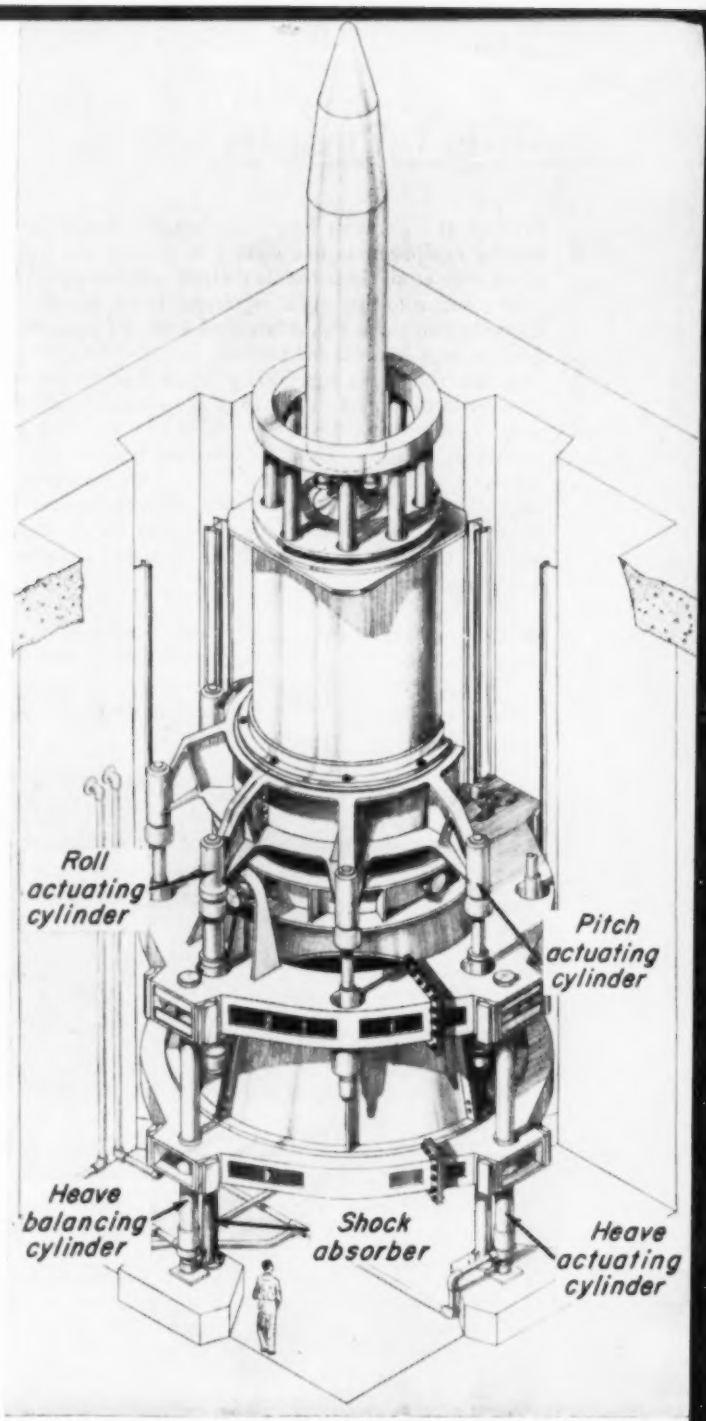


FIG. 1. SHIP SIMULATOR FOR THE POLARIS is installed at Air Force Missile Test Center, Cape Canaveral Florida. It will be operated by Lockheed Aircraft for Navy Bureau of Ordnance.

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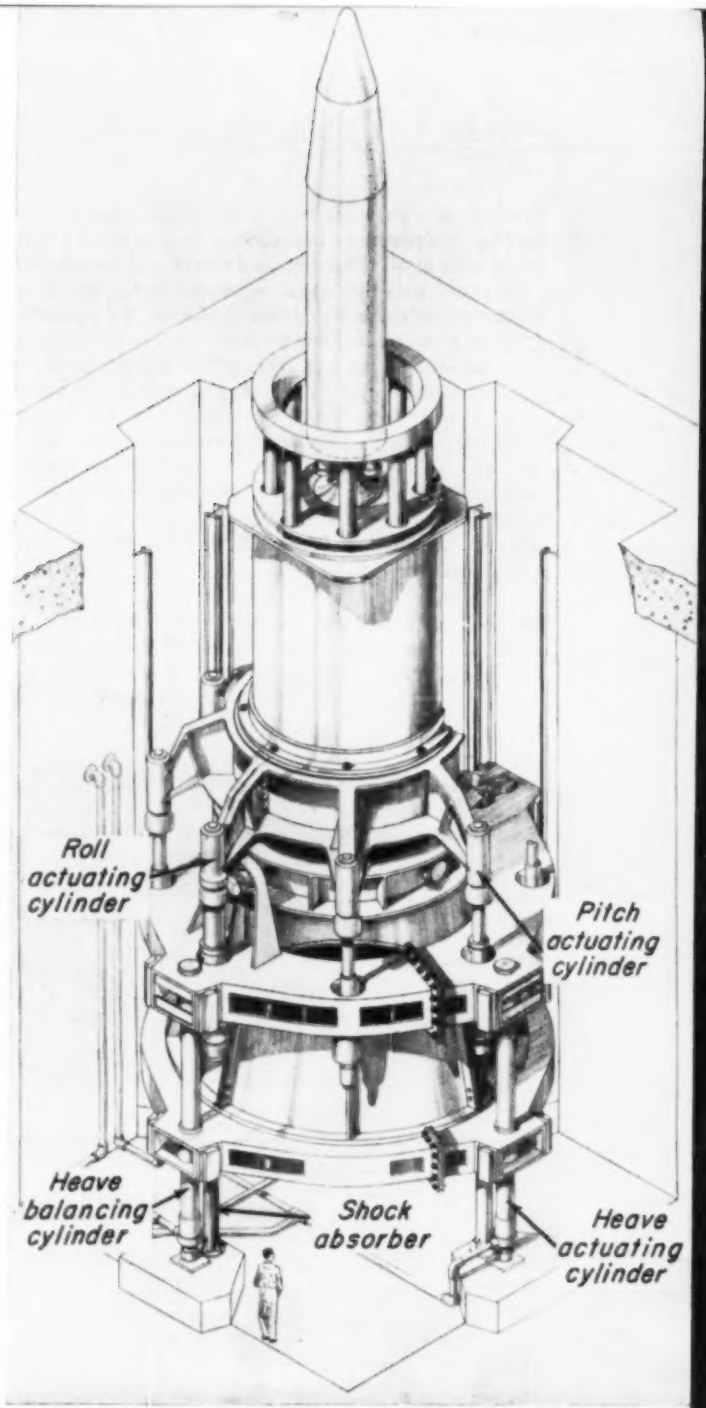


FIG. 1. SHIP SIMULATOR FOR THE POLARIS is installed at Air Force Missile Test Center, Cape Canaveral Florida. It will be operated by Lockheed Aircraft for Navy Bureau of Ordnance.

Pressure at high water level is the cutoff value of the pump. Special unloading equipment is unnecessary to protect the hydraulic system. The pump runs at all times but its delivery and horsepower input are limited.

In addition to theoretical requirements for harmonic motion, the pump characteristic curve was determined from the pressure to overcome guide friction, pipe friction, and pressure drops between the pump and the simulator actuating cylinders. This pressure depends on fluid velocity and is greatest at maximum discharge, and zero at blocked discharge. Most important, since the velocity is controlled by the throttle valve, pump pressure must be high enough to overcome friction and force fluid through the valve at the higher speeds. This flattens the required pump characteristic curve as shown so that it does not actually drop sharply from maximum discharge. The actual required characteristic shown in Figure 2 was given in the pump purchase specification and was closely matched by the pump manufacturer.

• **Component Design**—Peak force requirements in the heave system were based on lifting approximately 350,000 pounds.

The heave cylinder force is determined from the weight which must be held by the cylinder, plus the force to give the added harmonic acceleration.

Concluded on page 76

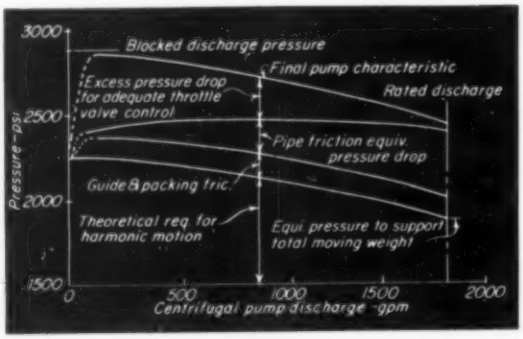


FIG. 2. PUMP characteristic curve is determined by adding additional pressure for friction and valve pressure drop to that for supporting weight and providing harmonic motion.

WHY USE A CENTRIFUGAL PUMP?

Sinusoidal motion of the simulator requires harmonic variation in force and velocity. Speeds and forces vary with the position, although their maxima and minima do not necessarily correspond. Comparing this to a vibrating, spring-mass system with one degree of freedom, governed by similar equations of motion, the velocity (flow rate) is a maximum when passing through mid-point, and zero at the ends. Acceleration (force, pressure) is a minimum at the mid-point and a maximum at the end points.

A curve showing the variation in cylinder speed (or system demand) with time would be a sine curve. The corresponding cylinder pressure would also be a sine curve lagging the demand curve by a quarter cycle when plotted on the same time scale. A centrifugal type pump is ideally suited to these requirements because of its drooping characteristic providing pressure and flow in the inverse relationship needed.

• **Heave Circuit Design**—Water is drawn from the pressurized storage tank, which pressurizes the pump inlet, and is pumped into the accumulator. To start from the lowest position, the INLET throttle valve is opened by the cam, which simultaneously closes the OUTLET throttle valve. The cams are on a common shaft driven by a rotary hydraulic actuator. The actuator is positioned by an electro-hydraulic servo valve which is actuated by a servo control system. Water passes through an air pilot-operated, solenoid-controlled STOP valve which is electrically closed under emergency conditions.

The pilot-operated OVERTRAVEL valve is controlled by a directional valve actuated by a strike-cam mounted on the simulator. Movement of the simulator above or below a safe height actuates the directional valve which applies pilot pressure to shut the OVERTRAVEL valve. After the OVERTRAVEL valve, water enters the actuating cylinders which drive the simulator upward aided by the balancing cylinders. During downward travel the weight of the simulator forces water out of the cylinders at a controlled rate through the OUTLET valve to the pressurized tank. At this time, the THROTTLE valve cam closes the INLET valve so the pump delivers to the accumulator.

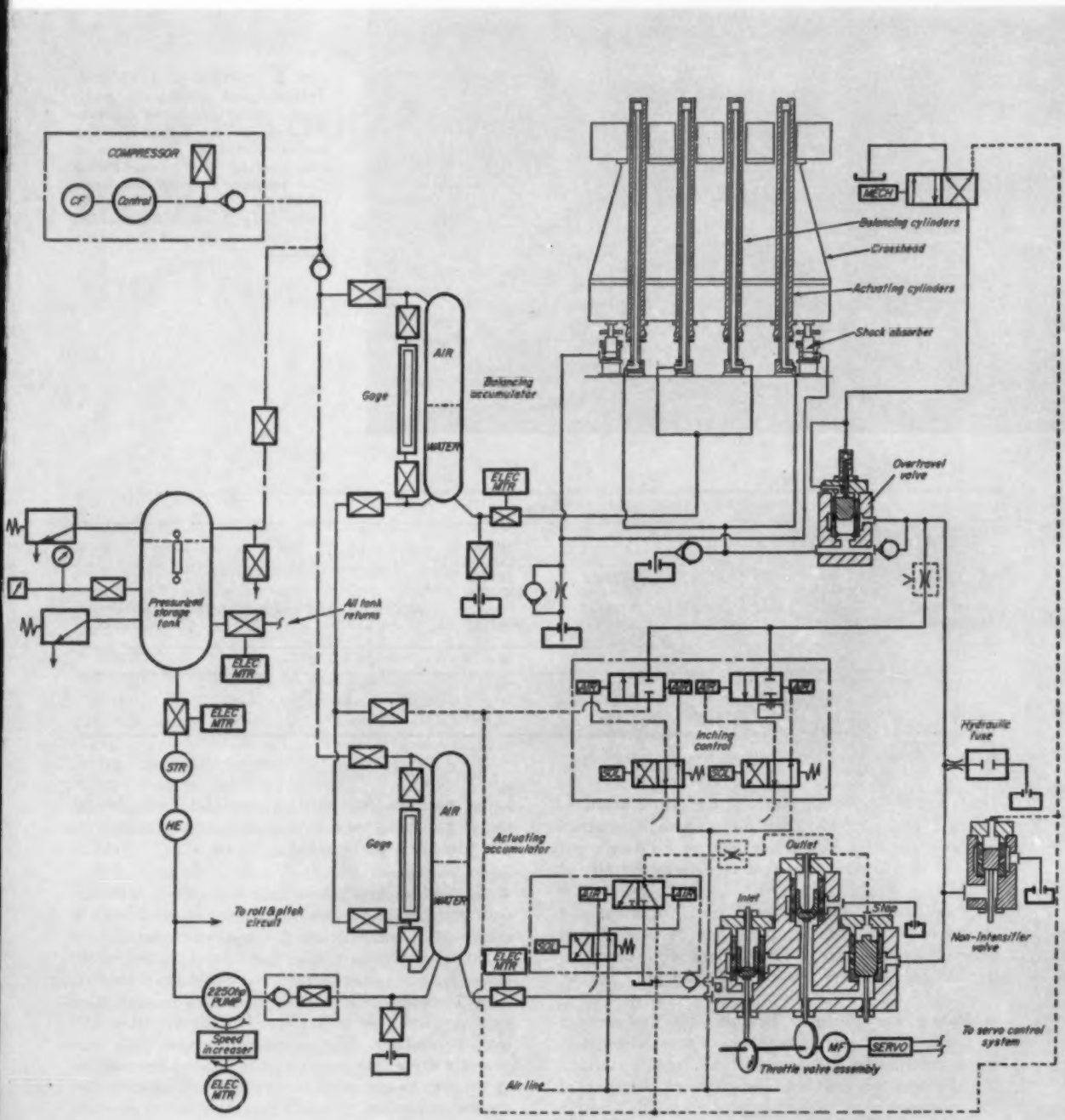
The NON-INTENSIFIER valve is a safety feature which prevents excessive pressure from developing because of a break in the balancing circuit, a vertical thrust applied suddenly, or a quick stop during descent. The valve opens when the ratio of system pressure to pilot pressure is greater than the ratio of areas above and below the valve spool. When the NON-INTENSIFIER valve opens, it passes water to tank. This has a powerful damping effect on disturbances, because it produces considerable energy dissipation. If the valve fails to relieve a pressure surge, a hydraulic fuse, set for a slightly higher pressure, ruptures.

To prevent cylinder cavitation and to replace leakage during standby, the actuating cylinders are connected to tank through a check valve.

Solenoid-controlled, pilot-operated inching control for very slow vertical motion is provided for missile handling and other jobs. The inching system supplements the regular servo-controlled system which is disconnected during inching.

Motor-operated gate valves at the high pressure accumulator outlets are positive hydraulic locks for the simulator. A blocking valve combining a check and gate, at the pump discharge prevents accumulator pressure loss by "motoring" the pump. They also permit pump start-up at minimum power.

The balancing and actuating accumulators and the low pressure storage tank are charged by a compressor which is con-



nected to each by valve selection. The compressor is shut-off automatically by a pressure switch when charging is complete. Manual reset is required before re-starting.

To prevent shock because of too rapid a descent, hydraulic buffers are installed with each cylinder. They are connected to the tank through a check and orifice. For normal motion, which is quite slow at the end of the stroke, water flows in and out of the buffers. When they are compressed too fast, the orifice creates a back pressure which decelerates the simulator. At other points in the stroke, the servo system responds to disturbing forces and positions the THROTTLE valve to prevent excessive speeds.

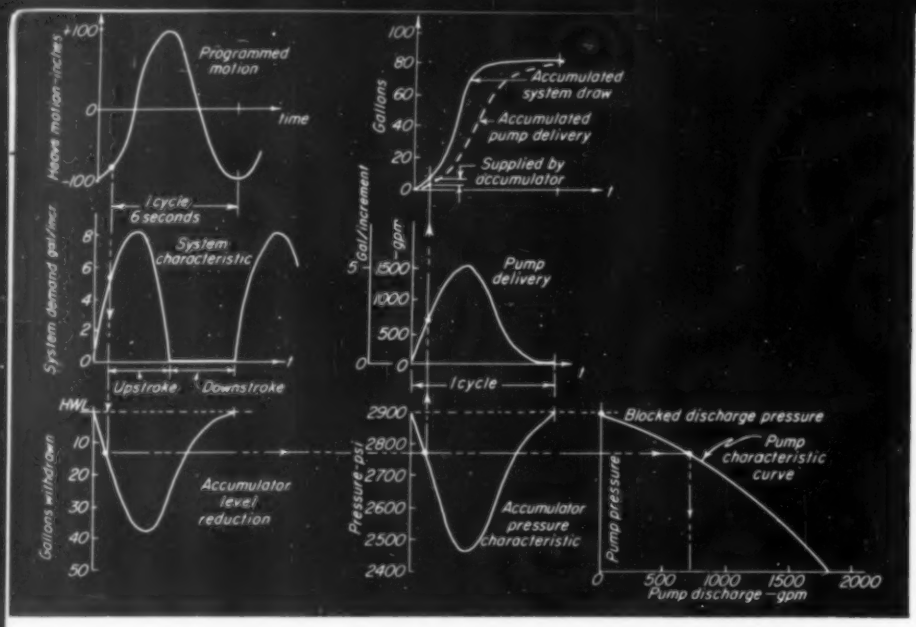


FIG. 3. SYSTEM BEHAVIOR is determined graphically with curve of programmed motion. Accumulator level and pressure are calculated for increments of time during the cycle. Pump flow rate and delivery are determined for this pressure. Accumulator supplies difference between system demand and pump delivery.

Table I

BEGINNING INTERVAL	TIME INCREMENT	SIMULATOR POSITION AT END OF INTERVAL	SYSTEM DEMAND DURING INTERVAL	INITIAL ACCUMULATOR LEVEL (BELOW HIGH WATER)	ACCUMULATOR PRESSURE	PUMP DISCHARGE RATE	PUMP DELIVERY
	Sec	In.	Gal.	Gal.	psi	GPM	Gal.
1	0.1	0.53	0.86	0	2900	0	0
2	0.1	2.10	2.54	.86	2885	160	0.27
3	0.1	4.70	4.11	3.13	2650	340	0.57

This total is about 500,000 lb. at the lowest position. The roll and pitch cylinder forces were determined similarly, but they depend not only on the weight but also the *distribution* of weight relative to the gimbal points.

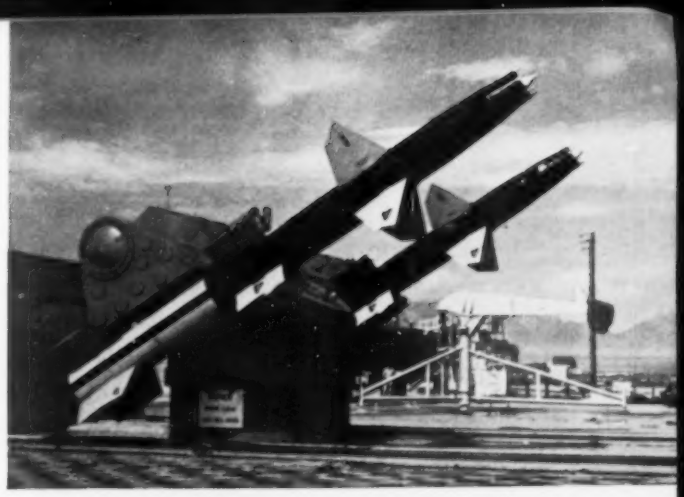
Other factors such as wind loads, friction, and change in height of the center of gravity were used to establish cylinder areas. Calculations were based on the blocked-discharge pressure of 2950 psi.

• **Pump Accumulator Design**—The performance of a centrifugal pump combined with a hydropneumatic accumulator is quite different from a constant displacement pump-accumulator system, because of the relationship of volume to pressure of the centrifugal pump. Sizing the pump, accumulator and other components is often complex. The significant factors are the pump flow-pressure characteristic, system demand, and accumulator level (or pressure) as functions of time. System demand and accumulator level can be described mathematically, but pump characteristic is obtained experimentally. As a result, in designing components for this system a semi-graphical method was used to analyze the system during one cycle of operation.

It was assumed that the actuating accumulator is at high water level when the simulator is at rest in its lowest position. Any starting conditions may be assumed but these were chosen as most representative. The procedure is illustrated in Figure 3.

• **Graphical Analysis**—Time intervals of 1/10 second were chosen to give an accurate analysis with a minimum of computation. A 6-sec cycle time was selected. The cylinder displacement for 1/10 sec is obtained from the programmed motion of the simulator. Since the pump is initially at blocked discharge pressure, demand must be supplied initially by the actuating accumulator. The accumulator level falls and pressure drops. The pressure at the end of the time interval may be computed using either adiabatic or isothermal expansion, depending on the speed of pressure change. This pressure then becomes the initial pump pressure for the next time increment. The same computing process is repeated, except the pump now discharges. This rate is picked off the pump characteristic curve. It is assumed to be constant during the 1/10 sec increment, so that the total pump discharge may be determined by multiplying. Flow from the accumulator is now the difference between system demand and pump discharge. A new accumulator pressure is determined and the process is continued. Table I shows calculated values for the first three time increments. ▼▼▼

Wrap-around hydraulics guides the Talos



THE TALOS MISSILE (prime contractor: Bendix Products Div., Missiles, Mishawaka, Indiana) uses hydraulics to move the control surfaces. These surfaces are the "wings" closest to the noses of the missiles shown here on a launcher. Fins at the center are fixed stabilizers. The fins furthest aft are on a booster section which falls away soon after the missile is launched.

THE hydraulic system that moves the Talos missile's control surfaces must fit in a limited sleeve-like space between the skin and the large ram air inlet tube for the airbreathing ramjet engine. Because hydraulic components are small for their force or power output the system fits in nicely.

• **Hydraulic System**—Pressure for control surface movements is generated in two ways on the Talos. During the launch and boost portion of flight, a nitrogen pressurized accumulator does the job. When enough pump pressure has built up, a ram air turbine driving a fixed-displacement pump supplies fluid. Pump output is controlled by throttling inlet air to the turbine. Hydraulic pressure supplied to a small actuator moves the throttle valve to close it when pressure builds up to the required operating value.

The pump, air turbine, gas bottle, accumulator, and reservoir are a manifolded assembly along with some of the valving, Figure 1. This photograph shows how these components are assembled so they will fit in the ring-like space available.

Electrohydraulic servo valves are supplied with fluid through individual filters and pressure compensated flow control valves, Figure 2. The flow controls limit the amount of fluid supplied to the servo valves to the maximum amount required.

Small, single-acting lock cylinders are an integral part of the control surface actuating cylinder. They are spring applied to lock the control surfaces in position and released by pressure. ▼▼▼

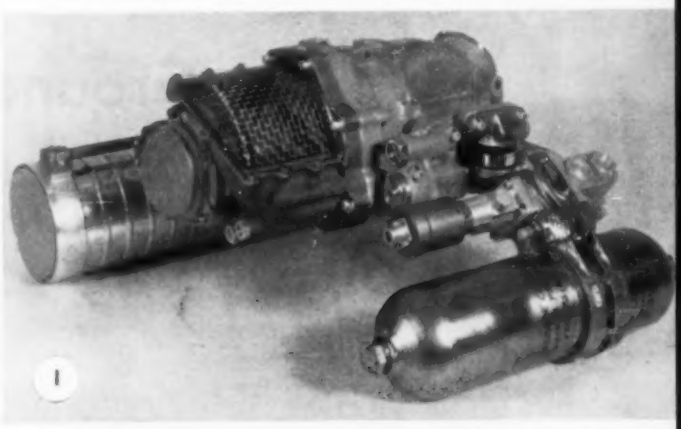


FIG. 1. HYDRAULIC PRESSURE sources for the Talos are manifolded. Shown here are the pump, air turbine, reservoir, gas bottle, accumulator, and nitrogen valving.

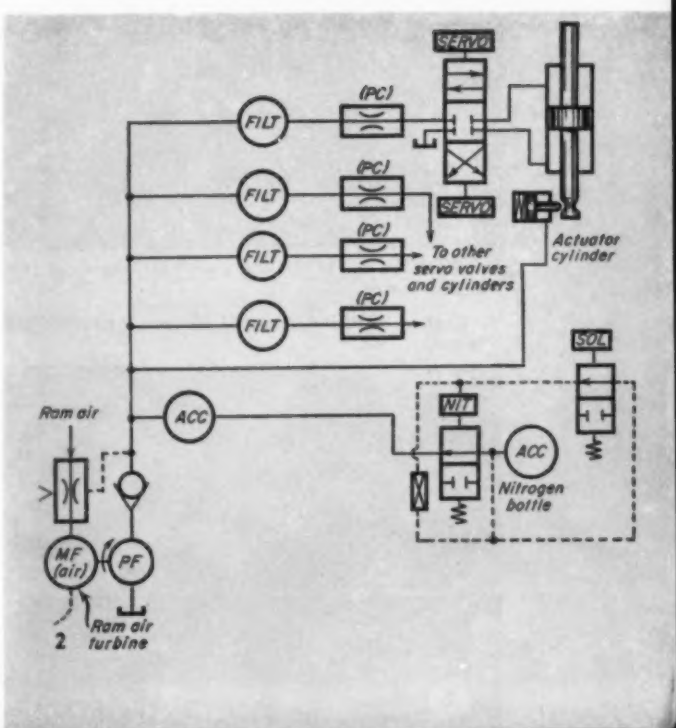
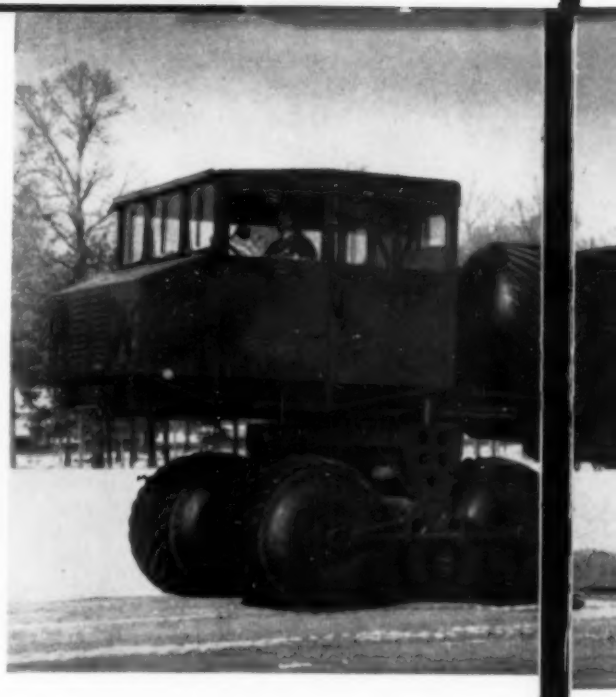


FIG. 2. HYDRAULIC CIRCUIT diagram for the Talos.

There are many applications of hydraulics and pneumatics in missile ground support systems, Goodyear Aircraft Corporation's engineers and their subcontractors use fluid power to do quite a few jobs.

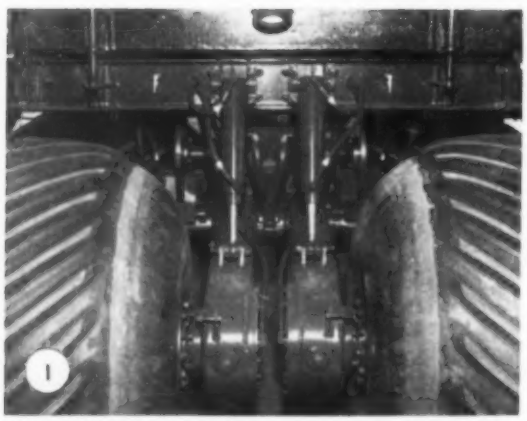
Basic building block in the system is a large truck. The truck, built by Four-Wheel Drive Auto Co., weighs less than any of the standard military vehicles, has higher mobility because of its eight wheel drive and low-pressure, super-traction tires, and is air transportable in a Lockheed C-130 or larger aircraft.

- Translauncher
- Hydraulic Crane
- Power Pack



Ground support system for

TRANSLAUNCHER



PNEUMATIC CYLINDERS control angle of four-wheeled bogies.

TRANSLAUNCHER supported by four hydraulic levelling jacks.

The mobile launching platform for the Matador and Mace is a semitrailer, called a Translauncher, towed by one of the truck units. The truck has hydraulic power steering and a pneumatic system, Figure 1 to adjust the angle of the 4-wheel bogies with the ground. Beside transporting the missile, the Translauncher hydraulically levels itself, moves the missile into the right positions for fueling, checkout and launching, and lifts itself off the bogie on which it rolls.

Four hydraulic cylinders, two at the back and two at the front lift the entire trailer frame and missile off the bogie and the tow truck, Figure 2. The aft pair of cylinders work together with a common control valve. Those at the front work independently.

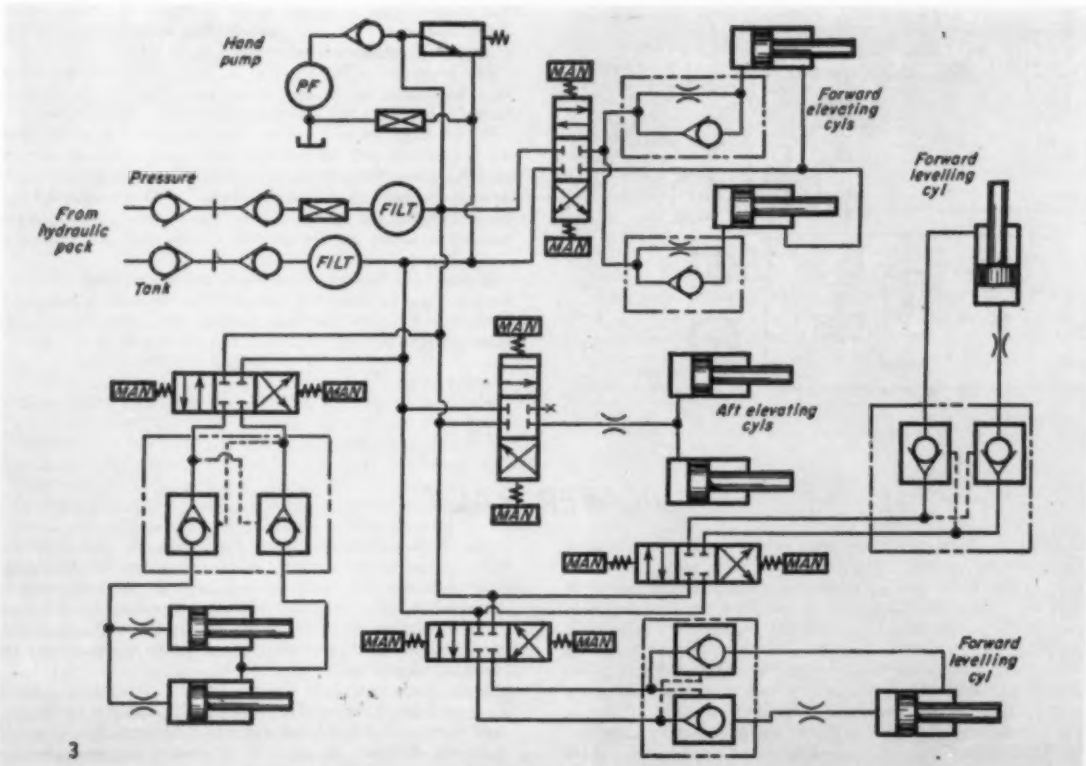
The missile support frame is raised from the trailer frame by four other hydraulic cylinders. Again there are two forward and two aft.

● **Hydraulic Circuit**—As the circuit diagram, Figure 3, shows, the Translauncher has its own hand pump and tank for use when the hydraulic power pack, a part of the ground support system, is not available. However, both pressure and tank connections are usually made to the pack with quick-disconnect couplings.

The rear leveling cylinders are synchronized by using a single valve to operate them both. Flow control valves are in the lines for the trailer lift-pressure. A pilot-operated check valve in each line prevents any cylinder drift, thereby assuring a steady platform. The forward levelling cylinders are independently controlled so the Translauncher may be levelled on a slope. Pilot checks are used there, too, to prevent drifting.

A single valve controls the rear elevating cylinders. Their speed is controlled by a single flow control in the line. As the circuit shows, they are single-acting cylinders. Forward elevating cylinders are double acting, operated simultaneously by a single valve, and synchronized for lowering by flow controls paralleled by checks. This lets the missile be elevated fast.

Mace and Matador missiles

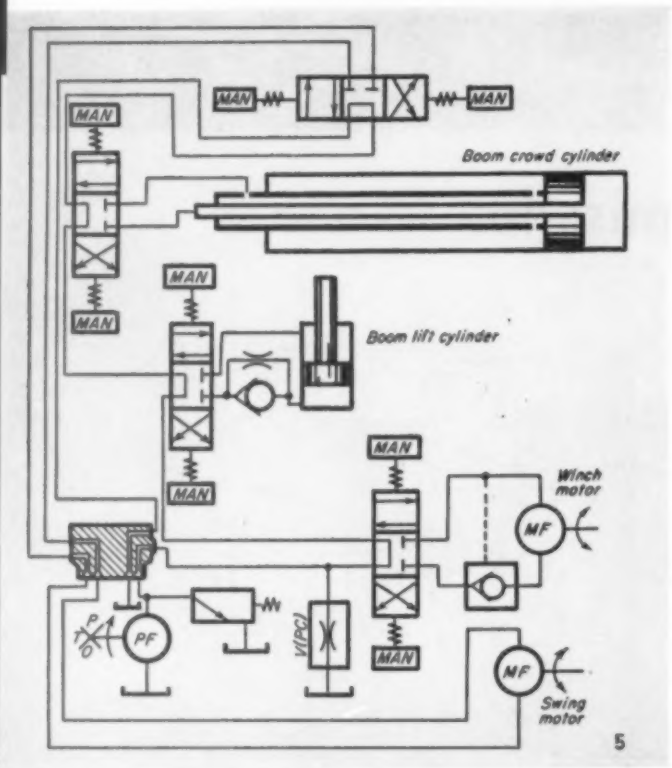


HYDRAULIC CIRCUIT DIAGRAM of the Translauncher.

HYDRAULIC CRANE

ALL-HYDRAULIC CRANE mounted on the MM-1 truck.

CIRCUIT DIAGRAM of the crane hydraulic system.



For handling missile components, such as nose section, and wings, in the ordnance and assembly areas (see Figure 2) a mobile crane is necessary. This unit was designed by Goodyear Aircraft Corp. specifically for this purpose and is mounted on the MM-1 truck, Figure 4. All crane motions are hydraulically powered. The turntable is rotated through 360 deg by a vane-type hydraulic motor. Another vane-type hydraulic motor drives the cable drum to raise and lower the crane hook. A double-acting cylinder raises and lowers the boom. The boom is crowded (extended and retracted by a double-acting hydraulic cylinder.)

● **Hydraulic Circuit**—The hydraulic circuit diagram is shown in Figure 5. A 48 gpm pump driven at 1400 rpm by a power takeoff from the truck engine supplies oil to the system. The pump pressure line runs to a large swivel fitting at the top of a pedestal in the center of the rotating table. From this fitting, pressure is fed to a foot pedal-operated bypass flow control valve. When the pedal is released, flow through this valve is 30 gpm and 18 gpm is supplied to the working circuits. If the pedal is pushed down all the way, there is no flow through the valve. Any in-between value is, of course, possible.

From the flow-control valve oil flows to a bank of four, manually-operated, 3-position, 4-way, tandem-type valves. From there, pressure and return lines run to the hydraulic cylinders and motors. Lines for the table rotating motor are run through the swivel fitting because the motor is mounted on the stationary part of the crane base. A worm gear reducer and the driving pinion and ring gear give a total reduction of 338.4:1.

The cable drum hydraulic motor drives the drum through a 50:1 speed reducer. A pilot-operated check valve in the line that connects the hydraulic motor to tank for down motion of the cable keeps the load from drifting down when the motor is stopped. Cable speeds vary from 1 to 45 fpm.

The boom lift cylinder is 9¼ in. ID. It will raise the boom form horizontal to 40 deg above horizontal. A fixed flow-control valve limits the lowering rate of the boom cylinder.

The boom crowd cylinder has 5-in. bore and 8-ft stroke. Rod end is anchored and the cylinder body moves to extend and retract the boom. Both oil connections to this cylinder are made through the rod end. Oil to the blank end flows right through the hollow rod. Oil for the rod end passes through the passage between a sleeve on the outside of the rod and the outer surface of the rod.

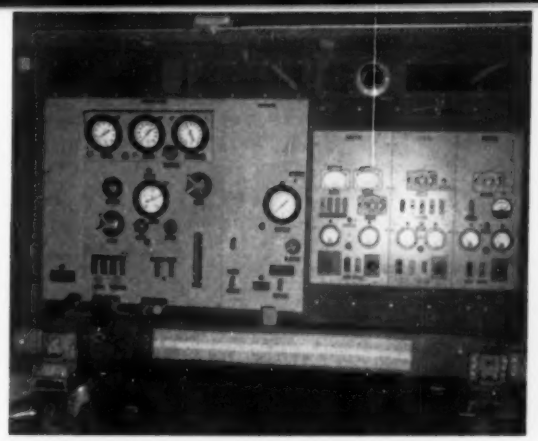
Because the control valves have tapered spools, all crane motions may be precisely controlled by combining movement of the valve handle with movement of the bypass flow-control valve pedal.

POWER PACK

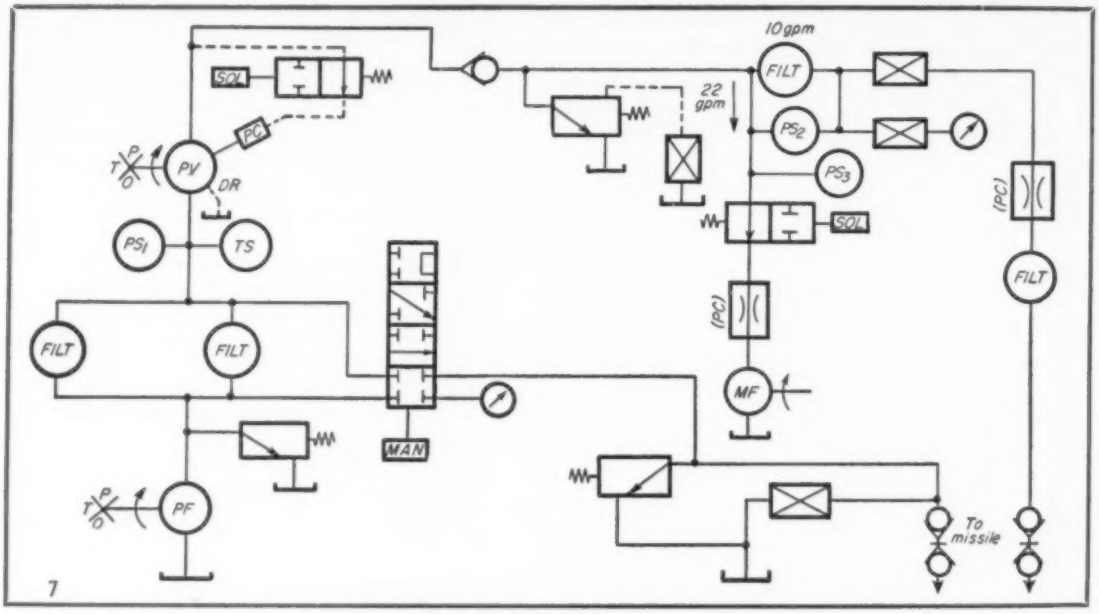
A hydraulic-pneumatic-electrical power pack unit designed for mounting on the MM-1 truck, Figure 6, is an important part of the Mace ground support system. Electrical power is used for lighting, operation of solenoid valves in the pneumatic and hydraulic circuits, and other things. The hydraulic pack supplies pressure fluid for the Translauncher and ground checkout of the missile hydraulic system. The pneumatic power supply provides air at 100 psi for operating hand air tools, and at 3500 psi for use on a recoverable training missile to eject parachutes and inflate rubber shock absorbing bags.

● **Hydraulic Pack**—Circuit diagram of the hydraulic pack is shown in Figure 7. A fixed-displacement vane pump supercharges the variable-displacement, pressure-compensated main pump. Both pumps are driven by a gear box driven by the MM-1 truck engine. A magnetic clutch connects the main pump to the gear box. PS_1 (pressure switch) stops the main pump by disconnecting the magnetic clutch if pressure in the main pump inlet line drops below 55 psi. A thermal switch connected at the same place stops the pump by disconnecting the clutch if oil gets hotter than 180 F.

Main pump output is 32 gpm max. The pressure compensator setting is 1500 psi. The 2-position, 2-way valve in the pressure compensator line helps warm the oil faster when it's cold. A switch energizes the solenoid to block the compensator line so the pump will deliver full volume at the 1750 psi setting of the relief valve downstream of the compensator. When



HYDRAULIC-PNEUMATIC-ELECTRICAL power pack unit. At the right, a closeup of the control panel.



HYDRAULIC CIRCUIT diagram of the powerpack.

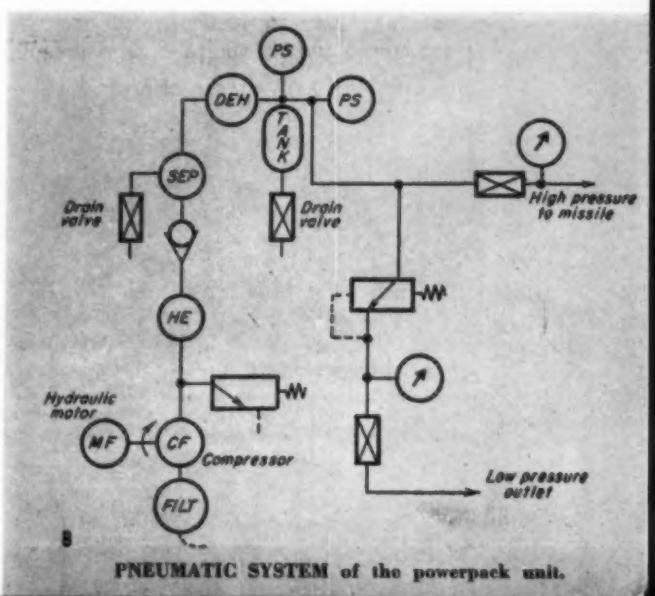
normal operating temperature is reached, the valve is opened to let the compensator function normally.

The 32 gpm pump output is divided into 10 gpm for the missile and 22 gpm to run the compressor drive motor. Fixed flow-control valves are used to do this. Flow to the missile or Translauncher is filtered by a five-micron filter and a magnetic filter, A differential pressure switch, PS_2, connected across the 5-micron filter lights a warning light when this pressure differential reaches 50 psi. PS_3 is a normal operating pressure indicator. It closes to light an indicator whenever system pressure is 1500 psi or more.

The 2-position, 2-way valve in the line to the fixed-displacement hydraulic motor is operated by a pressure switch. When air pressure reaches its set value, the valve closes to stop the hydraulic motor which drives the air compressor.

A 4-position, low-pressure selector valve connects various test points to a low-pressure gage. Pressure upstream and downstream of the filters between the supercharge pump and the main pump can be read. Operating instructions recommend checking these pressures often and changing the filters when the pressure difference is 20 psi. Pressure in the return line from the missile or Translauncher can also be read by turning the valve handle to the right position.

● **Pneumatic Pack**—The pneumatic circuit diagram is shown in Figure 8. A 4-stage, piston-type compressor delivers 15 cfm at 3500 psi. Air from the compressor passes through a check valve to a moisture separator, a dehydrator, and then to a 1 cu-ft tank. Pressure switches are used to start and stop the hydraulic motor which drives the compressor and to light a normal-operating pressure indicator light. A pressure-reducing regulator valve reduces pressure to 100 psi for operating air tools. ▼▼▼



PNEUMATIC SYSTEM of the powerpack unit.

Power sources for spaceborne

• By William Groen, *Group Project Engineer—Missile Equipment*
Adel Precision Products, A Division of General Metals Corp.

Hydraulic control systems are common in missiles because they give high response, servo control with maximum reliability. They are small and light for their high performance.

MANY missiles, whether simple or complex, use hydraulics to actuate controls such as fins and elevons. In more sophisticated missiles such as the ICBM's and IRBM's, guidance, engine gimbals, and scanner drives are powered by hydraulics. These hydraulic systems are supplied by three basic types of auxiliary power units, usually called APU's. Designers have taken a critical look at hydraulic APU's and have narrowed their choice to three basic types which suit missile configurations and performance. These are battery-powered, cold gas, and hot gas systems.

An APU is selected on the basis of endurance time that an amount of energy is required. This is measured in horsepower seconds. Table I shows how the three systems compare in endurance as well as other selection factors.

Each of the three systems has a different energy source which varies from a simple, rugged, one-shot system to a complex, liquid-fuel and oxidizer hot gas system. The number of hydraulic components varies, depending upon what the system must accomplish. The design objective in each is simplicity, reliability, and light weight.

Table I

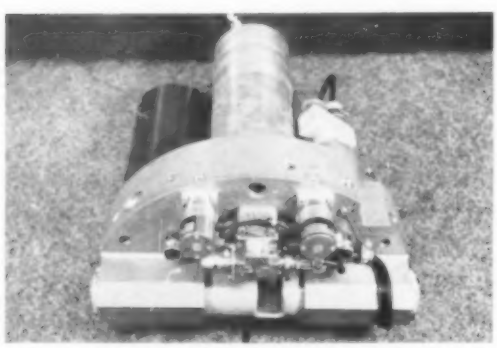
Comparison of Power Sources

	BATTERY-DRIVEN	COLD GAS	HOT GAS
Duration (Hp-Seconds)	5—1000	1—200	50—Unlimited
Reliability	1	2	3
Weight Short-10 sec Long-10 min	Equal 2	Equal 3	Equal 1
Space Required	2	3	1
Re-use for Checkout	3	2	1
Storage	2	3	1
Cost	2	1	3

1—Best suited. 2—Acceptable. 3—Not recommended.

BATTERY-POWERED SYSTEMS

Some of our first operational missiles used batteries as a primary source for their APU's which operate from 1500 to 3000 psi. The batteries supply low voltage, electrical power without complex rotating machinery. The hydraulic system is then powered by a motor-pump combination.



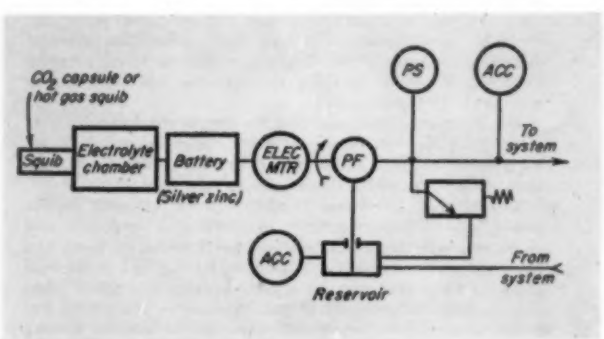


FIG. 1. BATTERY POWERED system. Squib, either CO_2 capsule or hot gas trigger, actuates electrolyte which is ahead of silver-zinc battery. Battery powers 28-volt motor which drives pump. Accumulator provides transient demands which vary rapidly. At times, system requires ten times more fluid than pump output. Spring-loaded piston accumulator keeps fixed pressure of 500 to 1000 psi on pump inlet regardless of altitude.

• **Weight & Size**—The batteries are usually the primary type in which the electrolyte is forced into the cells on launching. Advances in battery design in the past few years have made the systems very competitive in power per pound and unit volume. However, this advantage is usually lost in converting to mechanical power, because the electric-motor is heavy and large compared to a turbine for a hot gas system of comparable power. Higher battery voltages will reduce motor size, but it will probably never compete in size and weight with a hot gas turbine. Further, if high a-c power is required, inverters must be used, and these again are heavy and large.

The prime advantage of the system is its reliability. Other than battery filling, the system is about as foolproof as possible. The basic components have years of experience behind them, and long and costly development programs are not required. New developments in batteries, motors, and other components can be incorporated in an existing system after they have proven themselves. Battery-powered APU's have long storage life, often as much as five years. The recent silver-zinc batteries have made these systems almost indestructible. Battery-powered systems have had considerable development and application to missile hydraulic systems within the last year.

• **Packaged Battery System**—Figure 1 shows a packaged battery APU for a ballistic missile. This system has no tubing or fittings. All fluid lines are manifolded directly into the main aluminum forging. The forging has about thirty diverse passages that interconnect the pumps, accumulator-reservoir, control actuator, and pressure transducers mounted on it. The manifolding gives a rugged design that withstands vibration and shock. Another advantage is that the system can be assembled and inspected under clean manufacturing conditions and then sealed. This eliminates any last minute adjustments to tubing and fittings under field conditions. Since the unit is completely filled and charged at assembly, it is only necessary to plug into the missile for operation.

In one ballistic missile where environmental conditions are about the most severe found in any missile today, vibration ranges from 20 to 500 cps and shock loads exceed 125 g's RMS. The battery-powered APU for this missile has been tested at over 1500 g's. The conservatively designed prototype APU weighed 125 lbs. But newer techniques and re-evaluation of system requirements will give production units weighing less than half of this.

COLD GAS SYSTEMS

Two variations of the basic cold gas system are now in use. One is the non-return type, where return fluid is dumped overboard to lighten missile weight. These are designed so that the energy source and the hydraulic fluid are used up simultaneously to save weight. The other is a more complex, closed system where fluid recirculates.

The principal advantage of cold gas systems is their low cost. They are mostly used in short life applications, because they are economical only when they are light weight. Weight depends on size and quantity of stored gas. If a cold gas system were

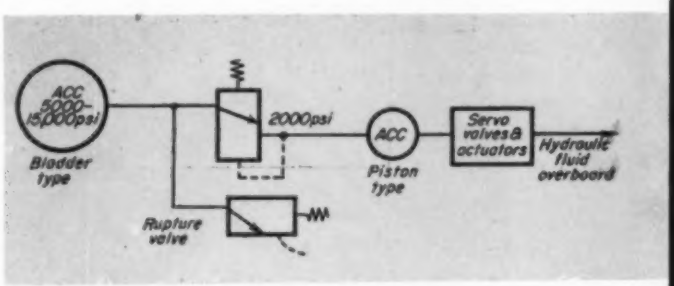


FIG. 2. COLD GAS SYSTEM used in the air-to-air Falcon and Nike-Ajax. Prime energy source is high pressure, inert gas, stored in spherical, reservoir-accumulator that has rubber bladder to separate hydraulic fluid. APU package is armed at launching by firing pin which pierces gas seal. Bladder expands against fluid and pressurizes system. The fast-response (2-millisecond) servo valve controls actuators in the control surfaces.

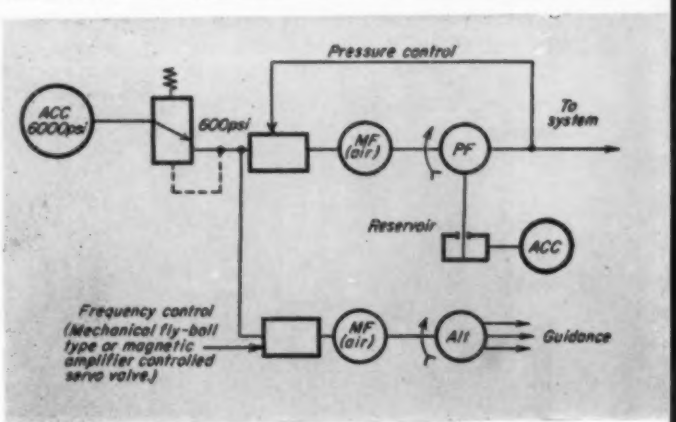


FIG. 3. CLOSED COLD GAS SYSTEM for Terrier uses two air motors. One of these drives hydraulic pump. The other drives an alternator. A pressurized reservoir in pump return line keeps system supplied with oil.

designed for long time operation, it would become bulky.

• **Operation In Missile**—Cold gas systems are used for short-time applications in the Nike-Ajax, and Falcon, at 1500 to 3000 psi. They are not limited by temperature, within the normal hydraulic system range. The prime energy is supplied from a high pressure gas source. This frequently is pressure from 2,000 to 12,000 psi. When the missile is launched, the APU is activated by an arming mechanism that punctures the sealed gas. This is operated by a lanyard, as in the Nike-Ajax, or by a cord device that operates at the start of the flight. Operation can also be delayed.

Where reservoir pressure is 10,000 psi, this is too high for direct use in the hydraulic part of the APU, so the regulator reduces the high pressure to 2,000-3,000 psi. This lower pressure gas then goes to an accumulator-reservoir package which is frequently a piston type. The regulator is omitted in some systems. They have a maximum pressure of 6000 psi.

Cold gas APU's are easy to package into compact units for easy installation and service. Like other packaged systems, they have to be extremely rugged to withstand terrific strains of vibration and shock.

HOT GAS SYSTEMS

The newest and most sophisticated auxiliary power units are those with their own miniaturized power-plant. The advantage of a hot gas source for a missile APU is in the large energy-per-pound of fuel.

Fuels vary from mono-propellant, in which both the oxidizer and fuel are combined, to bi-propellant, in which they are separate. Both solid and liquid fuels are used. The gas temperature to which this fuel can be converted ranges from several hundred degrees to many thousands of degrees, but a temperature must be selected only as high as the APU parts will stand. One factor is how long the parts are in contact with

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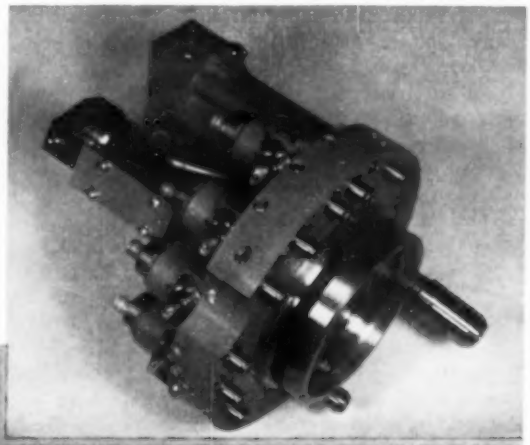


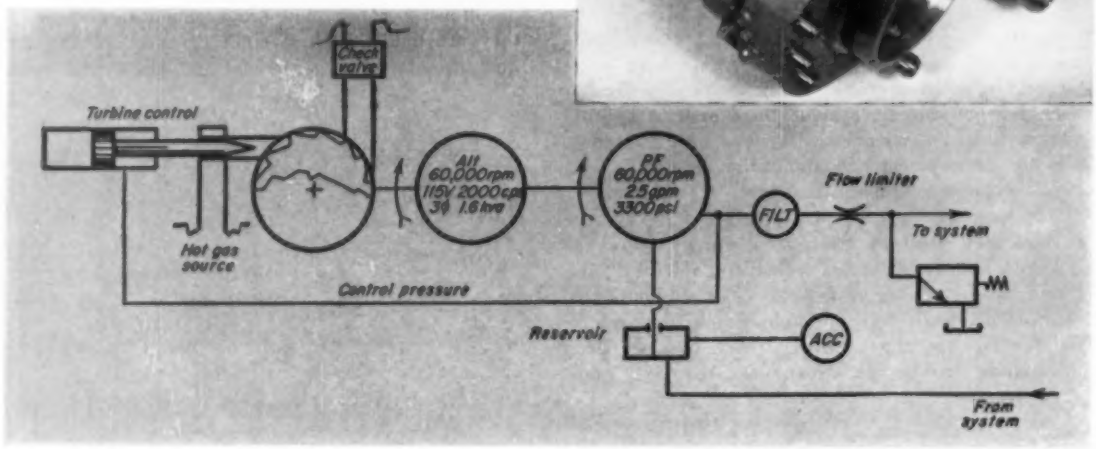


FIG. 4. HOT GAS APU for rocket torpedo, RAT. Gas at 2000 F and 2000 psi is supplied to nozzle which directs it at impulse turbine turning at 60,000. Alternator and high pressure pump are driven directly from turbine shaft making a light-weight, simple unit. Hydraulic output is 2.5 gpm at 3000 psi; alternator output is 1.6 KVA, 3-phase, 2000 cps. Running time is 10 minutes.

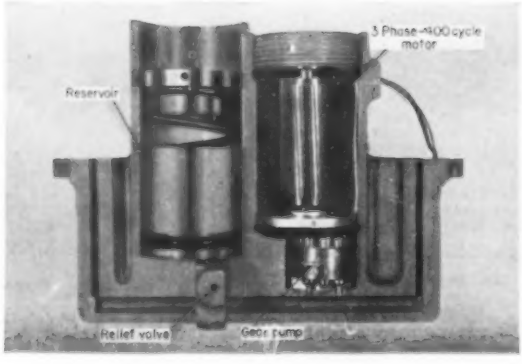
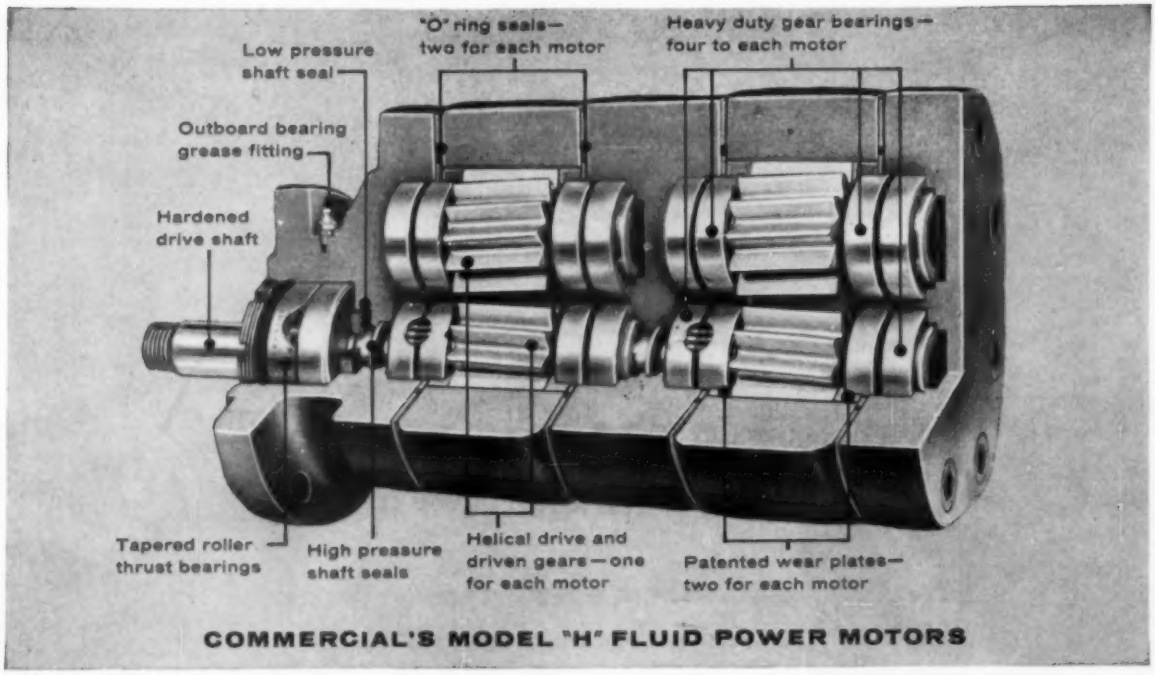


FIG. 5. SECONDARY APU is used in the Tartar, where main APU is amidships, but additional hydraulic power is required to drive radar scanners in front. Because of temperature, distance and severe vibration and shock, it would be hazardous to run tubing. Secondary APU is electrically connected to main APU and is limited to low power requirements, because a large electric motor in the secondary APU would cancel out weight savings of combination system.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COMMERCIAL'S MODEL "H" FLUID POWER MOTORS

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This Commercial Model "H" tandem motor actually involves two single motors of equal output mounted on one common drive shaft. When fluid power from the pump source is directed by simple valving into just one of the single motors, the shaft rotates at the high speed. The other single motor on the same shaft receives no input and therefore merely turns. When low speed is required, the total fluid power delivery from the pump is valved into both of the single motors. And of course motor torque at this reduced speed is doubled. This simplified control of two speeds—both low and high—is possible in either direction, forward or backward.

Each of the single motors in this Model "H" tandem motor has one-inch gears. With a fluid power input of about 15 gpm at 1200 psi, for example, when one of the single motors receives the entire input, rotation is 1200 rpm. When the same input is split between the two equal size single motors, rotation is 600 rpm.

Model "H" motors are available with gears in widths of 1", 1¼", 1½", 2", 2½" and 3". Any combination of gear sizes is practical.

More than two speeds

Even three speed operation can be obtained with Commercial double tandem motors when gears of different widths are used in each single motor. High speed operation results when the full pump delivery is valved to the motor with the smaller gears, intermediate speed when it is all directed to the larger gear motor, and slow speed when valved to both motors. One single motor having three-inch gears operating at 1600 psi at a speed of 1200 rpm would develop about 50 h.p. Commercial Model "H" motors are recommended for continuous duty operation at pressures up to 2000 psi and speeds up to 1800 rpm.

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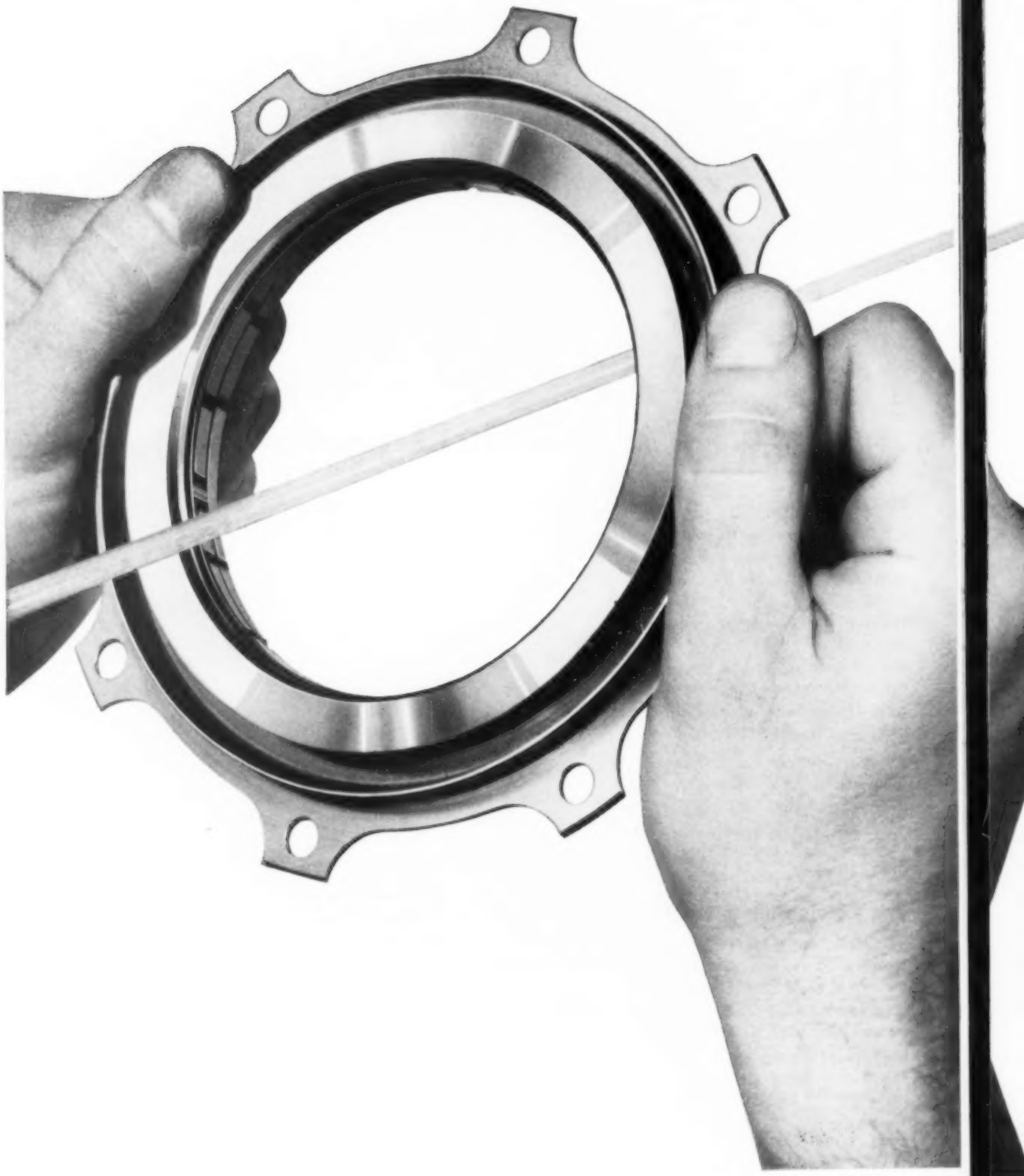

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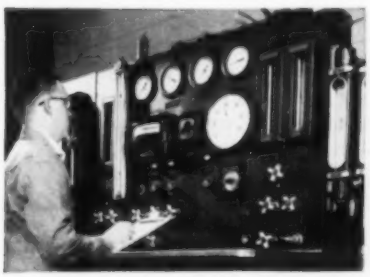

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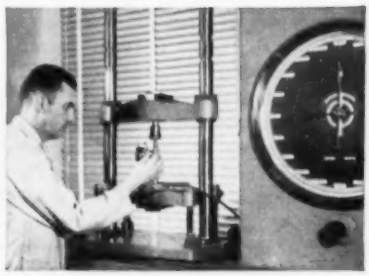

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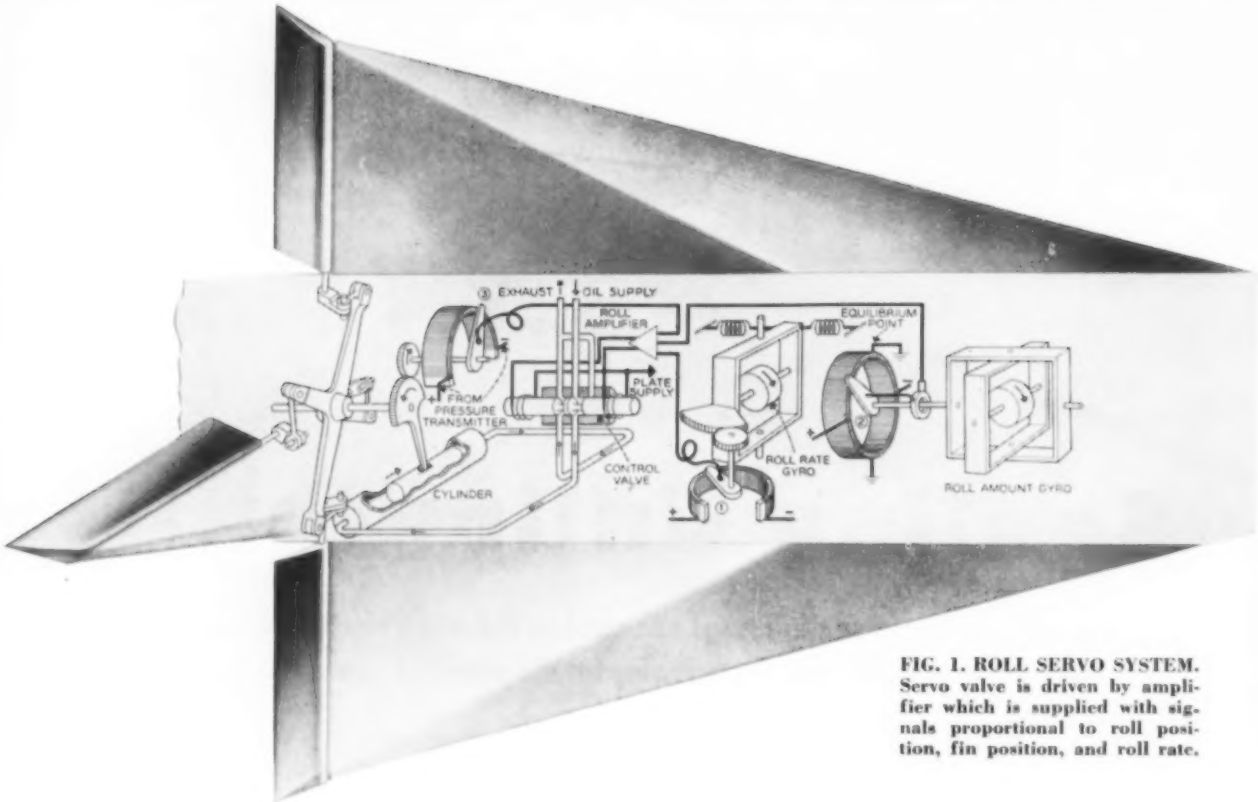


FIG. 1. ROLL SERVO SYSTEM. Servo valve is driven by amplifier which is supplied with signals proportional to roll position, fin position, and roll rate.

Nike's servo valve . . . how it controls roll

• By J. W. Schaefer, *Military Development Engineer, Bell Telephone Laboratories, Inc., New York, N. Y.*

THE roll positioning system is the simplest of three applications of the servo valve developed for the Nike missile, and it will show how the valve was developed and what its characteristics are. The system, shown in Figure 1, keeps the missile oriented in roll.

Reference for the system is a free-free gyro which is oriented on the ground prior to missile launch. A potentiometer senses gyro position and provides a d-c input signal to the amplifier which drives the valve.

A second potentiometer is geared to the missile roll control fins and produces a signal to the amplifier proportional to fin position. A third input to the servo amplifier is from a potentiometer driven by a spring-restrained gyro mounted with its sensitive axis aligned with the missile's roll axis. Its d-c signal is proportional to the roll rate, and provides some anticipation to the roll position loop. It acts like a tachometer in a conventional servo and also insures that the roll rate is limited to a value that can be handled by the position loop.

• **Servo Valve**—The valve shown in Figure 2 is a conventional 4-way type with inserts that are shrunk into the valve body. The plunger accurately fits in these inserts. Both the inserts and the plunger are hardened steel. Thickness of the inserts, and thus the location of the ports, is held to a very close tolerance by lapping their parallel faces. Outside diameter of the inserts is accurately ground, for a tight seal with the valve body. The hole is lapped with a diametral clearance of .0002 in. and the plunger must slide freely even with the small clearances. Longitudinal location of the plunger lands must also be controlled.

The valve is mounted with brazed, laminated manifolds which make connections to the valve. These adapt the valve to a specific installation without requiring changes in the valve itself. The upper manifold has fittings for connections to the cylinder and the lower manifold makes connections to pressure and exhaust.

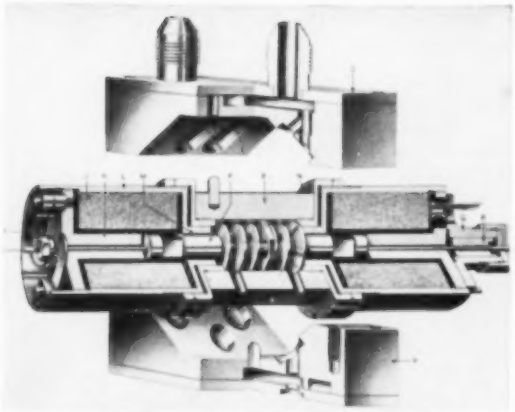


FIG. 2. SERVO VALVE is positioned by differential current on the coils. This magnetic force is opposed by the S-shaped spring. Manifolds at top and bottom adapted the basic valve to the installation.

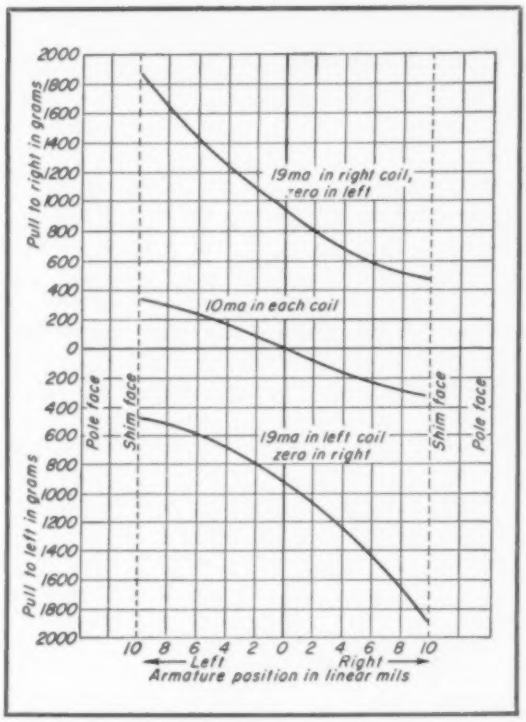


FIG. 3. RESULTANT FORCES on valve armature for balanced coil currents and for completely unbalanced coil currents.

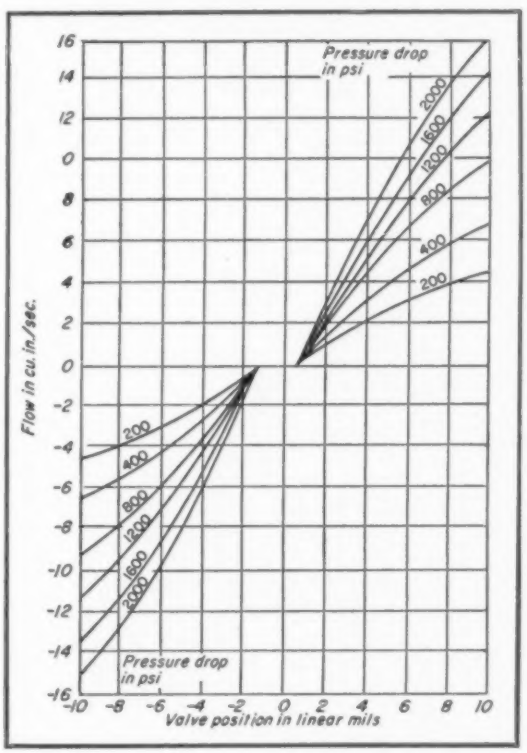


FIG. 4. VALVE pressure-flow characteristics.

• **Valve Actuators**—Pole pieces are screwed to each end of the plunger, and these move as an assembly to form the valve armature. A push rod attached to the armature is connected to an S-shaped spring which forces the armature toward center from either direction.

If equal currents are flowing in both coils, the valve remains centered. If the currents are not equal, the valve armature moves until the difference in magnetic forces is balanced by the spring force. Resultant forces on the valve armature are shown in Figure 3.

A second push rod attached to the armature drives an aluminum piston in a cylinder at the opposite end from the spring. The small radial clearance between this piston and the cylinder is filled with a viscous fluid which produces a damping force proportional to armature velocity.

• **Electronic System**—A push-pull amplifier drives the valve. With no input signal to the amplifier, the output currents in each coil are balanced. When a signal is applied, the output current is increased in one coil and decreased in the other. At maximum signal, the current in one coil is 19 ma and zero in the other. The dissipation in each coil with quiescent current is about 0.4 watt and full signal power is 1.5 watts.

A 250-cps differential dither voltage is superimposed on the push-pull d-c signal to overcome static friction. The resulting 1 ma differential current produces a magnetic force to break the friction of the stationary armature. This reduces the signal threshold by the amount of the dither current. The re-

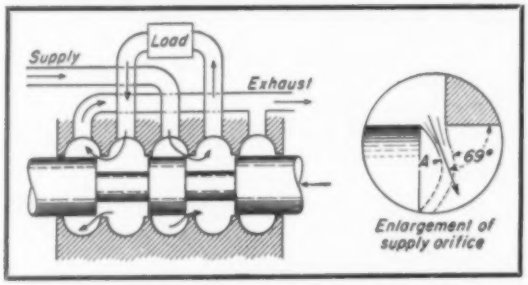


FIG. 5. FLOW THROUGH SPOOL TYPE VALVE. Departure angle of jet from a small orifice is 69 degrees from the longitudinal axis. Tests show that flow turns to follow the dashed path.

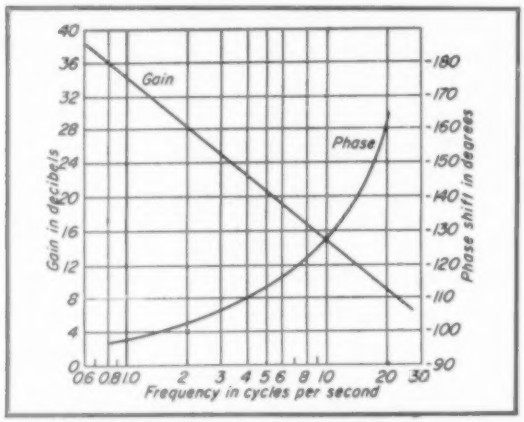


FIG. 6. FREQUENCY CHARACTERISTICS of the servo valve and amplifier. Part of the phase shift is due to inductance of the coils and relatively low source impedance of the amplifier used.

sultant increase in sensitivity to small signals reduces the phase lag at low amplitude.

• **Steady State Characteristics**—Relation between pressure drop and flow is not so simple as one might expect from a sharp-edged, orifice type control. For large valve openings, the pressure losses in the fixed orifices and passages of the valve body become an important factor. Pressure-flow characteristics are represented by the equation:

$$p = 10_{\varsigma} + \left(2 + \frac{455}{x^2} \right) q^2 \qquad (1)$$

where: p = Pressure drop, psi
q = Rate of flow, cu in/sec
x = Valve opening, linear mils

This equation was derived from test data from a model valve, and these data confirmed a computational analysis of the hydraulic circuit. Figure 4 is a graph of the equation showing flow against valve position for various pressure drops. There is a .001 in. difference between valve position and valve opening because of overlap at the ports.

• **Power Output**—Useful output power at the load is the product of the flow rate and the pressure exerted on the hydraulic actuator piston.

$$W = (P - p)q \qquad (2)$$

where: W = output power
P = supply pressure, psi

When the valve is wide open, x is .009 and equation (1) then becomes:

$$P = 10q + 7.6\,q^2 \qquad (3)$$

Therefore,

$$W = Pq - 10q^2 - 7.6q^3 \qquad (4)$$

This expression can be differentiated and equated to zero to find the maximum power:

$$\frac{dW}{dq} = P - 20q - 22.8q^2 = 0 \qquad (5)$$

and

$$q = \sqrt{0.192 + 0.0439P} - 0.439 \qquad (6)$$

Substituting for q in equation (3)

$$P = 0.333P + \sqrt{2.15 + 0.49P} - 1.46 \qquad (7)$$

At the normal supply pressure of 2000 psi

$$q = 8.95 \text{ cu in/sec}$$

Substituting for P in equation (7)

$$P = 0.333\,(2000) + \sqrt{2.15 + (0.49)(2000)} - 1.46 = 696 \text{ psi}$$

Substituting for P and q in equation (2)

$$W_{max} = 11{,}700 \text{ in-lb/sec} = 1.77 \text{ hp}$$

The equations show that if the valve is used with a very low supply pressure, the linear (laminar flow) term in (1) is dominant. In this case the maximum power output occurs when the pressure drop is nearly ½ the supply pressure. In the case of very high supply pressure the squared (orifice pressure drop) term is dominant and maximum power occurs when the pressure drop across the valve approaches 1/3 the supply pressure.

The ratio between the electrical quiescent input power to the coils and the maximum power output is about 1600 which is a power gain of 32 db. Based on a maximum signal, the gain is 29 db.

• **Dynamic Characteristics**—Flow of oil through a valve of this type produces a force on the plunger which tends to close the ports or center the armature. When the valve plunger is displaced in either direction, the fluid flow is metered by two control orifices in series as shown in Figure 5. Most of the pressure drop in the valve is across the two orifices and is equally divided between them. The maximum fluid velocity at this point can be computed by Bernoulli's Theorem.

In this valve the opening is small compared to other passage dimensions, many of the terms of the equation can be neglected and it becomes:

$$h = \frac{V^2}{2g} \qquad (8)$$

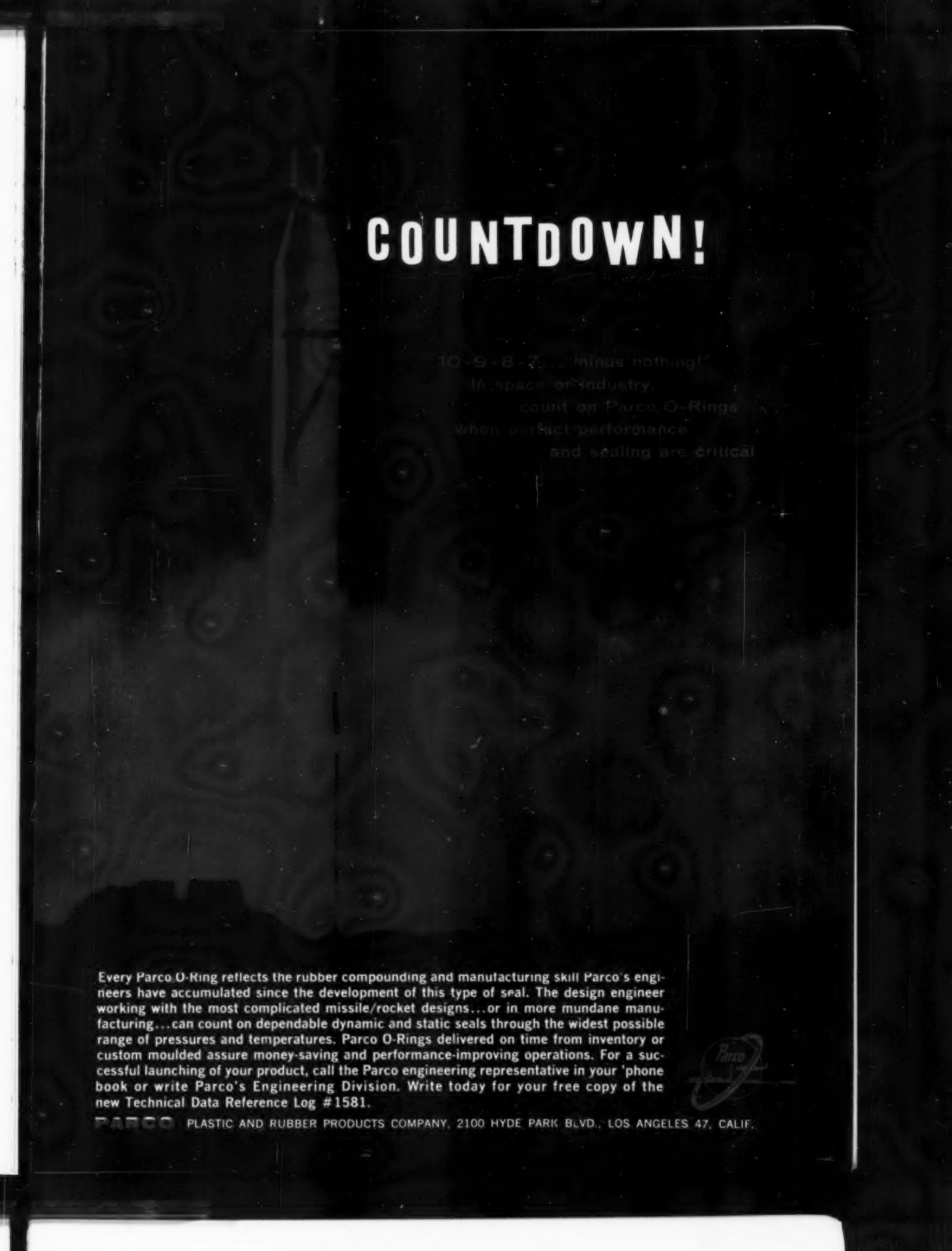
or

$$V = \sqrt{2gh} \qquad (9)$$

where: V = fluid velocity at the vena contracta, ft/sec
h = pressure drop across orifice, ft
g = acceleration of gravity, ft/sec²

Concluded on page 92

CIRCLE 105



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ALLIED CONTROL VALVE DIVISION

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NIKE'S SERVO VALVE

Concluded from page 90

The departure angle of the jet from a small orifice is 69 degrees from the longitudinal axis. Tests made with an orifice like those in a simple valve showed that the jet continues at this angle for a short distance only. Further downstream, the jet turns to hug the radial surface on the plunger. This action is shown by the dotted line in Figure 5.

Bernoulli's Theorem explains that pressure is exchanged for velocity. The low pressure within the jet stream pulls it toward the nearest wall of the cavity. The flow of oil over this surface reduces the pressure on that wall and unbalances the forces on the plunger.

The Bernoulli force was measured early in the development of this valve, but it was considered unimportant because of the high stiffness and large damping inherent in the design. The experimental models did not oscillate. Later the lapped clearances were increased and high ambient temperatures were encountered at the missile test location. These reduced the damping and resulted in oscillation. The external damper shown in Figure 1 was added to eliminate this oscillation. (Subsequent improvement in the internal design of the valve reduced it to the point where the need for the external damper has been eliminated.)

• **System characteristics**—The open loop gain and phase shift vs. frequency characteristics of the combination of the valve and the amplifier which drives it are shown in Figure 6. The servo characteristics were obtained by applying an input signal to the servo amplifier from an oscillator. The valve was driven by the amplifier in the usual manner. It controlled the flow of oil to a piston which operated a load equivalent to a typical aerodynamic load on the control surface. The voltage from the fin-position potentiometer was compared to the amplifier input. To prevent the piston from drifting to one end of the cylinder, it was necessary to close the loop by connecting the fin-position potentiometer output signal to the amplifier. The data were adjusted to correct for the error introduced in this way, and open loop conditions are represented. The equalization networks have compensating leading characteristics to prevent the oscillation suggested by the increasing phase shift at the higher frequencies.

If the servo acted according to minimum-phase network theory, the slope of the gain curve would start to increase at the high frequency. Nonlinearities caused by overlap, dither action, etc. cause this deviation from theoretical performance. Actually the slope does start toward 12 db per octave just above the frequency range shown. Part of the phase shift is due to the inductance of the coils and the relatively low source impedance of the amplifier used. Later amplifier designs have much higher output impedance which has greatly reduced this effect. ▼▼▼

Another article by Mr. Schaefer on the Nike system appeared in The Bell System Technical Journal, May 1957. Development of the servo valve started in 1945.

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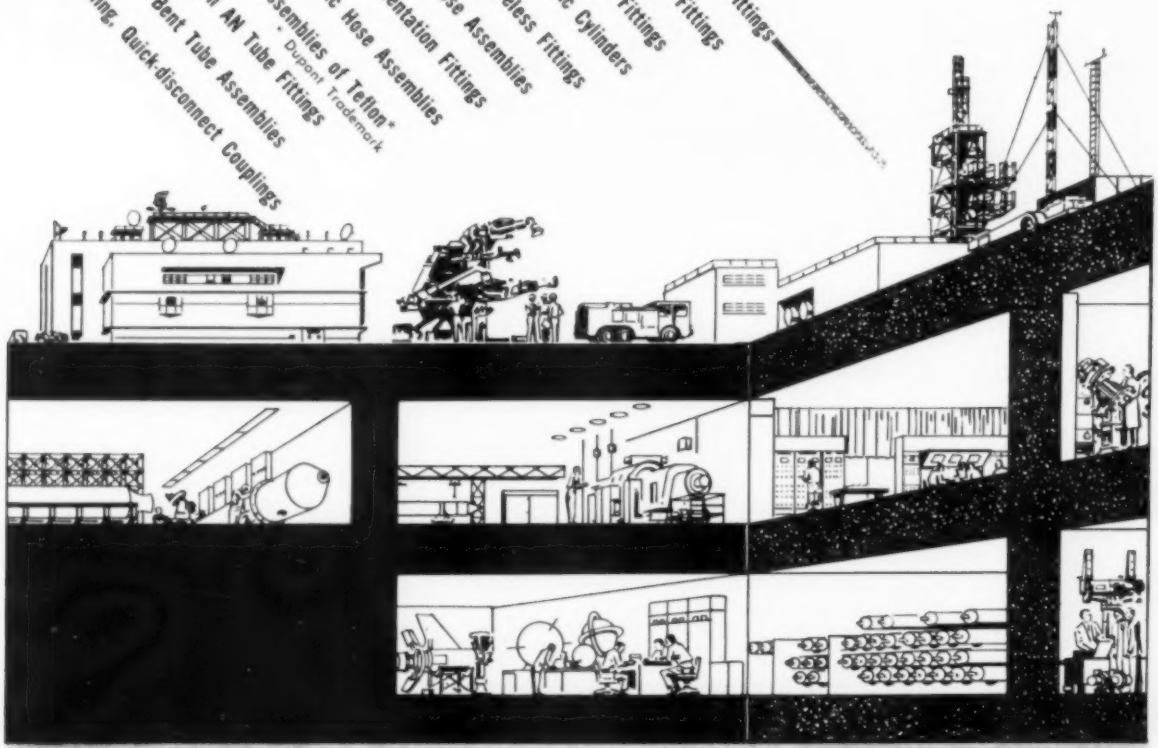

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Four Sparrow I air-to-air missiles are shown here slung below the wing of a Douglas Skynight. Photo courtesy Douglas Aircraft Co. Inc.

Hot-gas pressurized accumulator

THE PROBLEM: Design a small, light hydraulic pressure source for a missile with less than a minute flight time.

THE SOLUTION: Hydraulic system for Sparrow I is powered by hot-gas pressurized accumulator supplying 2000 psi to control surfaces.

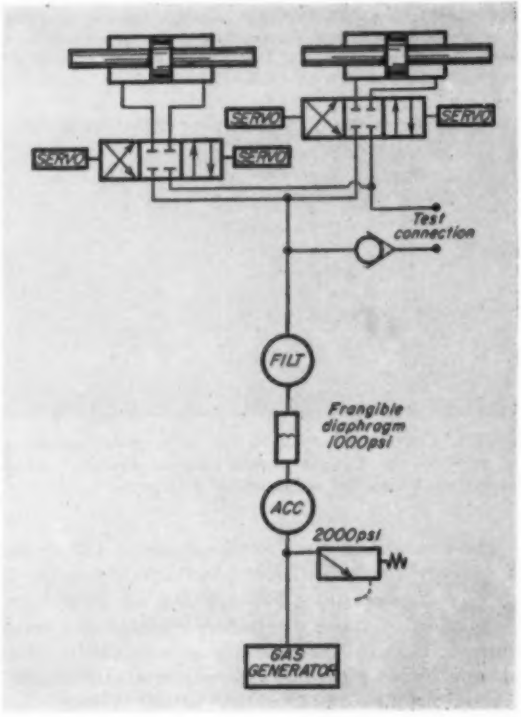

FIG. 1. CIRCUIT of the Sparrow I hydraulic system.

SPARROW I, developed for the U. S. Navy by the Sperry Gyroscope Co., is an operational, air-to-air missile. About 12 ft long, it weighs 300 pounds, and is driven by a solid-fuel rocket motor at over 1500 mph. A radio beam guides it from the launching aircraft to the target. Hydraulics move the control surfaces to keep the missile on the beam no matter how it shifts due to evasive action of the target.

Size, weight and total flight time (less than one minute) strongly affected hydraulic system design, and so did reliability and cost. The result is diagrammed in Figure 1.

• **Hydraulic System**—Pressure source is small, light and compact. It is a diaphragm-type accumulator, a small gas generator, and a gas-pressure relief valve. Relief valve and gas generator are fastened right to the accumulator, Figure 2. This unit will supply 22 cu in. of hydraulic fluid per sec. Total burning time of the propellant charge is about 30 sec. Operating pressure is 2000 psi.

As the circuit diagram shows, there is a metal diaphragm downstream of the accumulator. It bursts when hydraulic pressure is 1000 psi and fluid flows to the rest of the system. This diaphragm assures that none of the accumulator oil charge will be lost while the missile is stored. The rest of the system may be filled and checked out on the ground without disturbing the pressure source. The diaphragm is assymmetrically supported so it can withstand full test pressure on the downstream side.

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HOT-GAS PRESSURIZED ACCUMULATOR

Other ways of pressurizing the system for the short flight time, such as simply precharging the accumulator or pressurizing the accumulator from a charged gas bottle, were considered. However, the small size and weight of the gas generator make it first choice. A gas bottle to provide the same pressure for the same length of time would be both larger and heavier. The same is true of a charged accumulator.

FIG. 2. HYDRAULIC POWER package for the Sparrow I is a diaphragm-type accumulator, gas generator and gas-pressure relief valve. The "can" at the bottom of the unit contains the propellant charge.

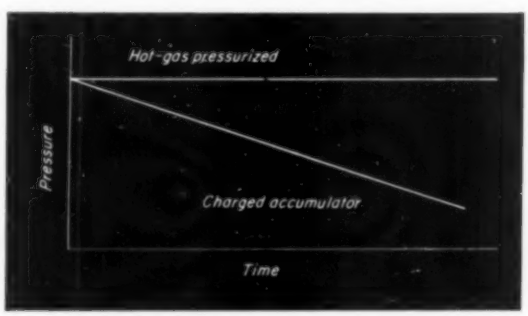

FIG. 3. CONSTANT PRESSURE throughout operation is provided by hot-gas pressurization. Available pressure from a charged accumulator decreases.

The accumulator has a total volume of 150 cu in. It is filled with 145 cu in. of hydraulic fluid. The 5 cu in. remaining allows for expansion due to ambient temperature changes. To prevent the hot gas from burning through the elastomeric accumulator diaphragm Sperry's engineers developed a special coating and the 30 sec burning time helped. Although the operation is normally one-shot, examination and tests on the diaphragm show that they could be used several times. ▼▼▼

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Table I
Hot Gas and Hydraulic Servo Comparison

SYSTEM	COST	WEIGHT	VOLUME
Hot Gas	1	1	1
Hydraulic, nitrogen charged accumulator	1.2	1.7	2.5
Hydraulic, propellant-driven turbine, pump	1.7	1.3	1.5
Hydraulic, propellant-driven turbine, pump (long operating time)	1.7	1.2	1.1

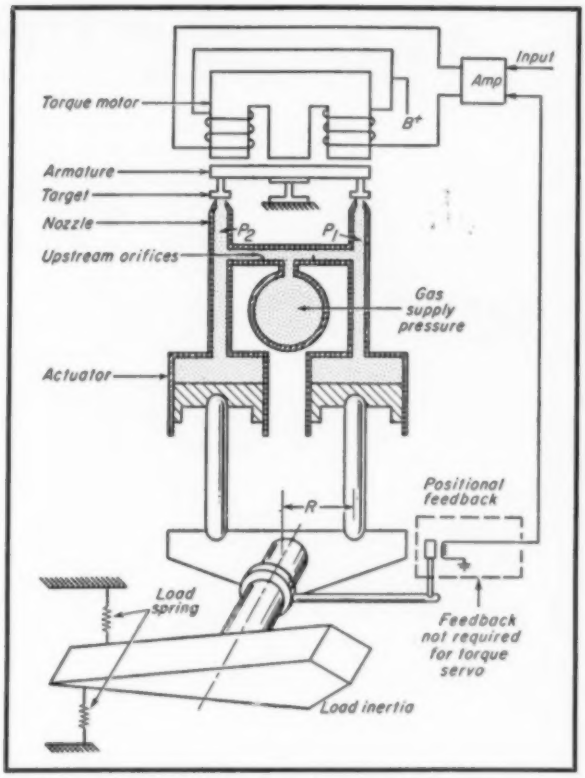

FIG. 1. SCHEMATIC DIAGRAM of a hot-gas servo.

If a hot gas can be used efficiently to pressurize a hydraulic system, wouldn't it be even more efficient to eliminate the gas-to-hydraulic pressure conversion components and use the hot gas itself in the actuator? The answer is, Yes, some times. Here, with the circuit for a practical hot gas servo, are answers to . . .

When to use a hot gas servo

• By M. Russell Hannah *Engineering Section Head for Mechanical Design*
Air Armament Div., Sperry Gyroscope Co., Great Neck, N. Y.

IF YOU use hot gas directly to power a servomechanism, you eliminate the need for a hydraulic or pneumatic power supply. You can save weight, volume and money. Just how much you save depends on how long the servo must work and what kind of hydraulic power supply it replaces. Table I shows what can be expected.

• **What It Is**—A workable hot-gas servo is diagrammed in Figure 1. The primary energy source is a gas generator which burns liquid or solid propellant fuels to produce high-temperature, high-pressure gas at a constant mass-flow rate. An input signal from a servo amplifier is fed to the torque motor of a flapper-nozzle valve. Deflection of the armature proportional to the input signal lets the flow of hot gas increase through one nozzle and decrease through the other. The increased flow through one nozzle causes pressure to drop across the orifice upstream of the gas generator and in the upstream chamber. Reduced pressure on the actuator piston on that side combined with a pressure increase on the other piston because of restriction of its nozzle causes one piston to move down while the other moves up.

Where the load reaction is proportional to deflection, as it is for a missile flight control surface where air load on the surface increases with deflection, feedback is inherent in the system and the load stops when the load reaction is proportional to the deflection of the torque motor armature. The feedback transducer shown on the diagram is not needed, in

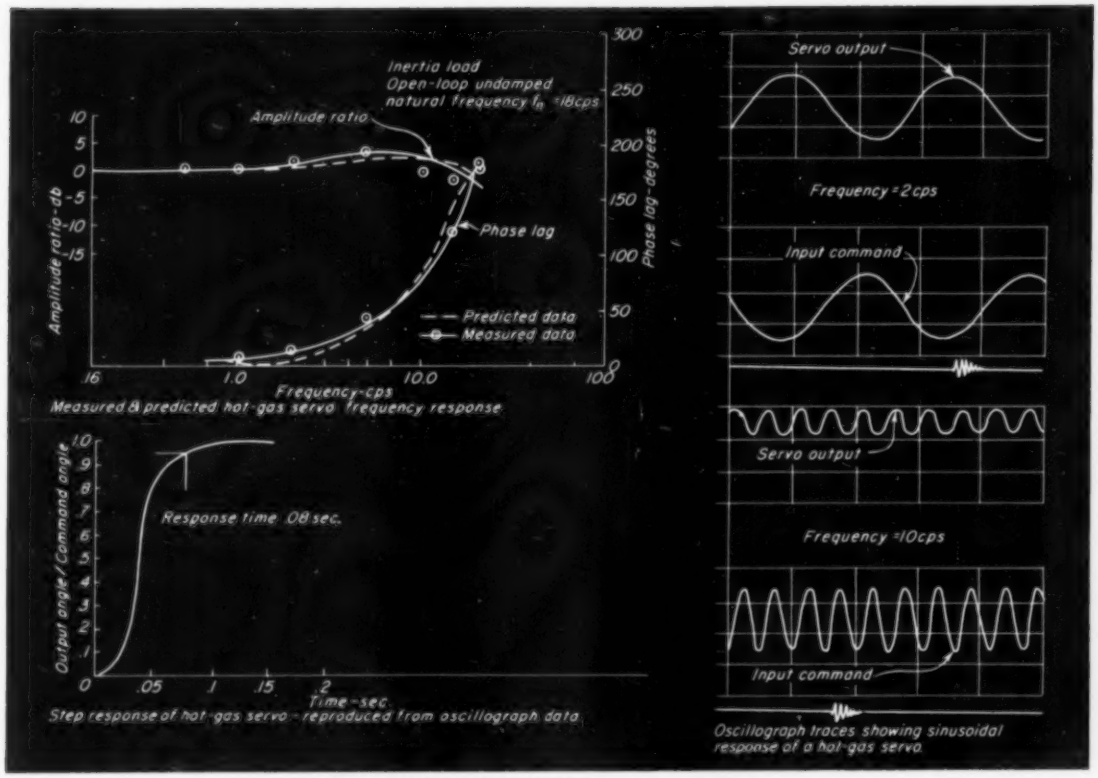

FIG. 2. PERFORMANCE DATA for a hot-gas servo.

such a case. Not only is the feedback transducer not required, but the servo also compensates for changes in control surface effectiveness that result from changes in speed and altitude.

If the load is primarily inertial, the feedback transducer is, of course, necessary to an accurate positioning system. The servo can also be designed to control other quantities by using the appropriate type of feedback transducer. A velocity servo, for example, can be had by using a velocity transducer.

• **Performance**—The actuator transfer function is the principal lag in the system and determines the bandwidth and stability limits of the closed-loop hot-gas servo. This transfer function consists of an integration times a quadratic lag. The natural frequency of this quadratic lag limits the maximum bandwidth of the servo. In general, the maximum bandwidth cannot be more than one-half the natural frequency of the actuator. A rule-of-thumb formula for the natural frequency of the actuator is

$$f_n = \frac{1.4}{2\pi}\sqrt{\frac{T_o}{J\delta_m}} \qquad (1)$$

where f_n = Undamped, open-loop, natural frequency of the actuator;
J = Load inertia;
T_o = Maximum required stall torque;
δ_m = Maximum actuator deflection angle from midposition.

Whether or not a hot-gas servo is dynamically capable of the performance required is determined by three things. They are:

1. Bandwidth needed
2. Stall torque to inertia ratio
3. Maximum angular deflection needed.

Equation 1 provides the answer to the first. Maximum angular deflection would, of course, be known. Equation 1 may be rearranged to give the minimum stall torque to inertia ratio. Assuming that a bandwidth of 10 cps ($f_n = 20$) is required and a maximum control deflection of $\pm$ 20 deg, (0.35 radian) the solution is:

$$\left(\frac{T_o}{J}\right)_{min} = \left(\frac{2\pi f_n}{1.4}\right)^2 \delta_m \qquad (2)$$

and for the conditions assumed

$$\left(\frac{T_o}{J}\right) = \left(\frac{2\pi 20}{1.4}\right)^2 \times .35 = 2800 \text{ rad/sec}^2$$

This shows that a gas servo can be designed for bandwidth of 10 cps if the stall torque to inertia ratio is at least 2800 rad/sec^2. It also shows that the higher this ratio is, the better and more adaptable a gas servo becomes. Performance curves for a typical hot-gas servo are shown in Figure 2.

• **Hot Gas Souces**—Either a solid or liquid propellant may be the energy source for a hot-gas servo.

Concluded on page 100

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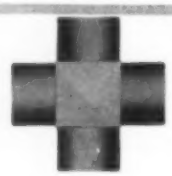

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WHEN TO USE A HOT GAS SERVO

Concluded from page 99

Ease of ignition, low burning rate, clean combustion products, and low sensitivity to ambient temperatures are the properties needed. Low temperature sensitivity and fast ignition are very important because a missile must get off fast even after long storage in the cold. The proper combination of propellant and ignitor do it. Gas generators have been developed that get to working pressure within 0.05 sec after ignition at —67 F.

Flame temperatures of commonly used propellants vary from 1800 to 3800 F. Common operating pressures are 500 to 2500 psi. Typical solid propellants are cylindrical end-burning grains that burn from one end to the other at typical rates of .15 to .3 in. per sec. Grains become objectionably long for long flights. Slower burning materials are being developed and grains have been shortened by folding or curving. Liquid propellants economize on space are best for long range missiles. ▼▼▼

***EDITOR'S NOTE:** One missile, now flying, the Sidewinder air-to-air missile, uses a hot-gas servo system for flight control actuation. The missile is said to be a masterpiece of design and production simplicity. Dr. William B. McLean, Technical Director, Naval Ordnance Test Station, who guided its development, received a $25,000 cash award under the government's Incentive Award Program for his work. In January of 1958, he received the President's Award for Distinguished Federal Civilian Service.*

POWER SOURCES

Concluded from page 84

the hot gas. For instance, in the Sidewinder, the time is so short that a plastic turbine wheel is used.

A hot gas APU has been developed at Adel for the RAT guided torpedo. This is a very advanced Naval rocket torpedo for surface-to-sub-surface and can be called an underwater, guided missile. It uses a solid propellant charge, and a high speed turbine as shown in Figure 4.

• **Frequency Control**—The turbine speed control to maintain constant electrical frequency is entirely hydraulic and uses the high volumetric efficiency of the pump. The pump delivers through a filter and flow control valve. Pump pressure is applied to a cylinder which controls nozzle opening. If turbine speed increases because of an increased burning rate of the propellant or a decreased load on the alternator, the pump output also increases. This results in a higher pressure drop across the flow control valve and increased pressure at the pump. This increased pressure is fed back to the turbine nozzle to close it until the preset speed is reached. At this point the feedback pressure acting on the control cylinder just balances the spring force.

The system has good regulation and controls alternator frequency within 1% with about a 30-cps response. Its biggest advantages are its small size, lightweight and simplicity. The system has a very high reliability. ▼▼▼

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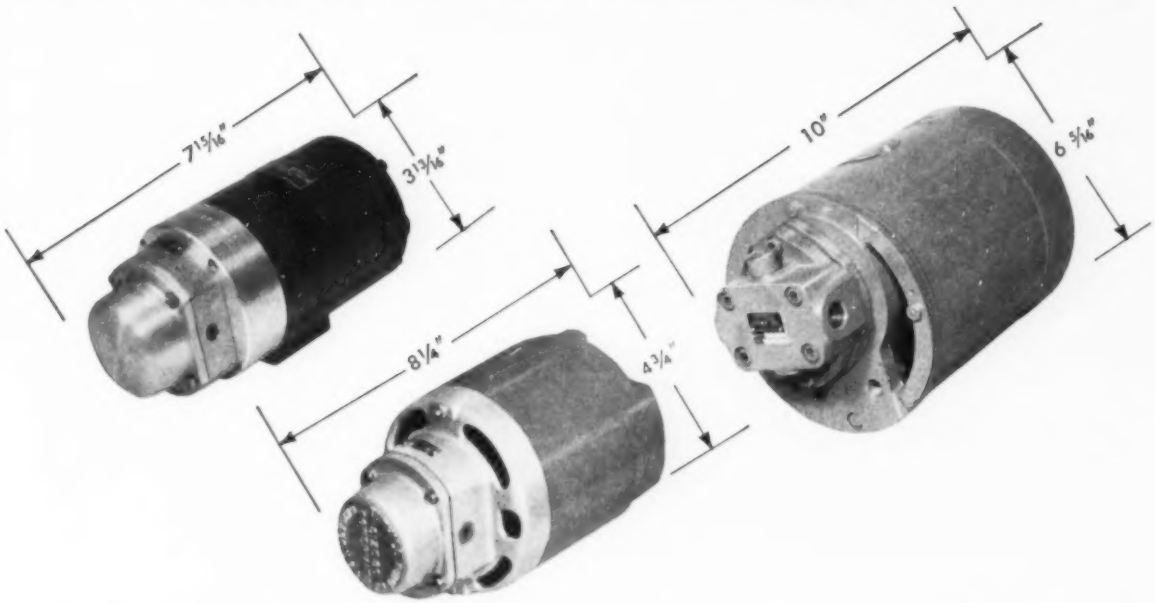

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The Powermite's compactness solves tough design problems. Its small size and low weight make it easier to install . . . boost production line productivity. The elimination of bases, couplings and other parts result in substantial economies. Its lower weight reduces shipping costs. And all Powermites provide the long trouble-free life which industry has learned to expect from Tuthill.

Wide range of combinations

A wide range of pump and motor combinations can be provided to meet individual requirements in hydraulics, lubrication, circulating, coolant, and other pump services. Three typical examples are shown above.

The compact unit to the left, developed for use on a small mobile hoist, combines an internal gear pump rated for 30 cu. in./min. at 500 psi, with a $\frac{1}{8}$ hp motor. The center unit, developed for a low pressure hydraulic application combines an internal gear pump with a capacity of 16 gpm at 250 psi with a $\frac{1}{12}$ hp motor. The unit at right combines a high pressure hydraulic spur gear pump, for rated conditions of 1 gpm at 1,000 psi with a $\frac{3}{4}$ hp motor.

Custom engineered for your application

Each Powermite model is custom engineered for a specific OEM application and is designed to permit substantial economies for high volume production. A few Powermite models are available from stock—for example, the 350 psi, 16 gpm model shown at center above. For small quantity applications Tuthill Close Coupled Pump and Motor Combinations can provide similar savings.

Manufacturers interested in learning more about the advantages of incorporating Powermite combinations into their products are invited to forward detailed specifications. Or, if preferred, a Tuthill Field Engineer will call.

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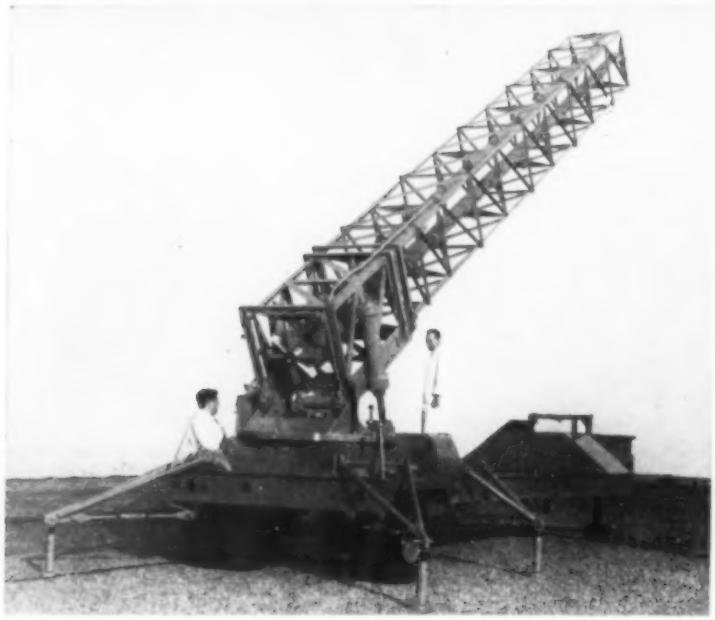
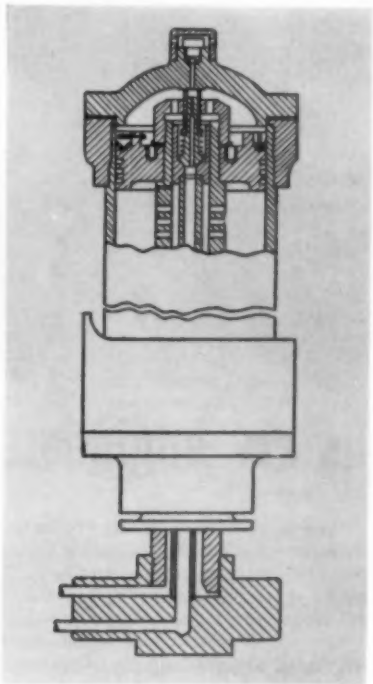


LAUNCHING TOWER gives Arcon and Iris rockets 35 ft. of guided flight until rocket speed permits control by its fins. Tower can be positioned within a vertical cone of 36-degrees included angle.

SWIVEL FITTING connects oil to the rotating turret. Two spool valves, mounted with the swivel, control flow to the two raising cylinders and the rotating motor.



Rocket launcher adapts fire engine design

• By Rudolf H. Edelston, *Atlantic Research Corp., Alexandria, Va.* and Hubert Walker, *American La France Corp., Elmira, N. Y.*

WHEN Atlantic Research Corp. needed a hydraulic system to raise and rotate their rocket launching tower, they made an unusual design decision. Rather than develop their own system from scratch, Atlantic engineers reasoned that the ladder control system from American La France's fire engine should be just what they wanted. The motions were just the same, and reliability was unquestionable. These ideas paid off when the system was adapted, with few changes, to the launcher for the Arcon and Iris high altitude sounding rockets used for meteorological studies.

The launcher tower has four rails to guide the rocket for 35 ft. These rails are adjustable radially to accommodate rockets with diameters from 6 to 15 in. and with fin diameters to 45 in. The tower is bolted to a cradle which is part of a rotating turret, and the whole assembly is mounted on the back end of a flat-bed trailer.

• **Swivel fitting**—Hydraulic connections to the rotating tower are made through a double walled, concentric, swivel fitting shown in drawing. The swivel remains stationary while the triple spool, control valve, which is mounted on top, rotates with the turntable. This design eliminates oil leakage, because the outer O-ring packings seal the return passage and are only required to hold oil at atmospheric pressure.

• **Hydraulic Actuators**—Raising the tower is done by two 6-in. cylinders mounted on either side. These have their rod ends fixed to the turret and their cylinder bodies trunnion-mounted to the tower. This simplifies connections to the cylinders through their hollow rods which have two passages. A metering check valve and flow control bushing are mounted in the upper end of each piston rod. The check valve is held on its seat in the piston rod by a spring, and its stem is guided by the piston rod nut. Bleeder valves are mounted in the top heads of the cylinders.

To raise the tower, pressure oil passes through the inner passage and check valve to the head end of the cylinder; return oil passes through the outer passage. To lower the tower, pressure oil passes through the

outer passage to the rod end of the cylinder. Oil in the head end closes the check valve and passes through the metering holes and the inner passage. The metering holes retard the downward travel of the tower even if a line breaks. An additional pilot-operated check valve in the cylinder line prevents drift-line with the valves. These cylin-shut-off.

Rotation of the tower is done by a screw type fluid motor driving through a helical spur gear reducer; worm and gear; and spur pinion and internal gear. The total reduction between the fluid motor and turret is 102:1. The motor torque rating is 14 in-lb/100 psi.

Remote valve control had to be used because of flame from the rocket at launching. Atlantic Research developed an electrical control that can be operated from 200 ft. away.

Each spool of the control valve is operated by a 1½ x 1½-in. spring-loaded cylinder mounted in ing of the tower during power ders are controlled in turn by solenoid-controlled, pilot-operated valves. ▼▼▼

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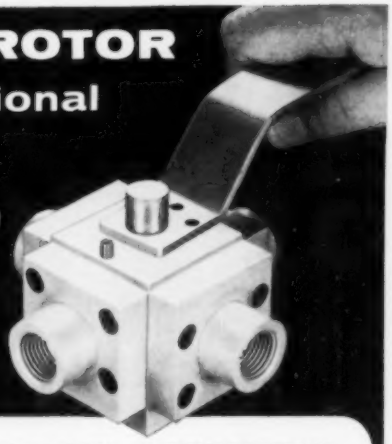

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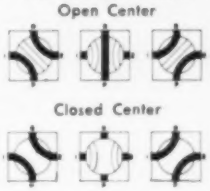

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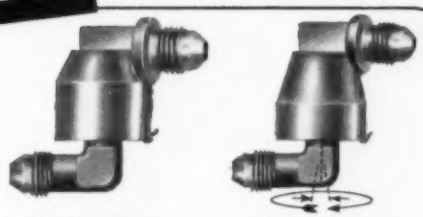

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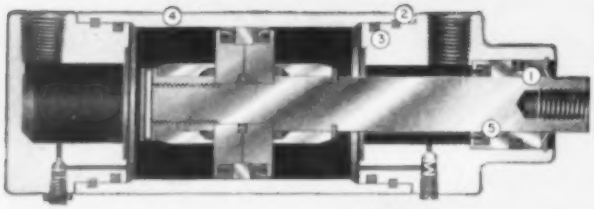

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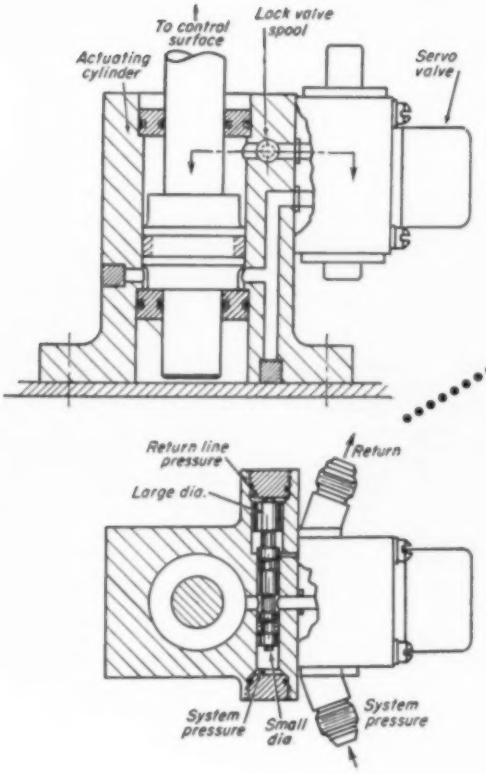

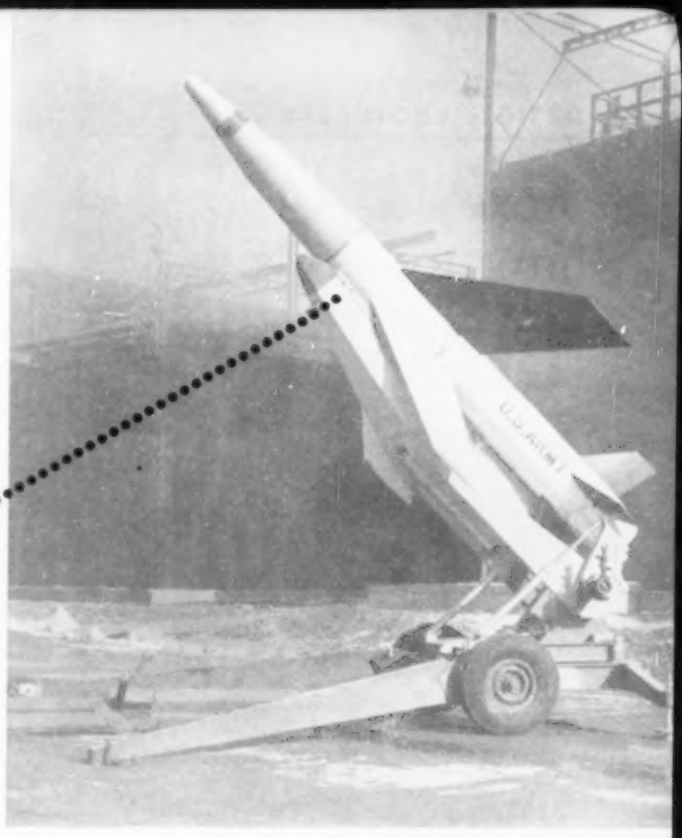

Hydraulic lock for missile control surfaces

• By E. A. Hilburger, *Principal Engineer*
Cornell Aeronautical Laboratory, Inc., Buffalo, New York

DESIGN of the control system for the Lacrosse missile required locking the control surfaces at a 3-degree angle of attack during launching. This roll bias, together with spiral launching rails, rolls the missile to cancel out thrust and fabrication misalignment.

A comparison between mechanical and hydraulic locking methods showed the hydraulic method was simpler, smaller, and more reliable. The hydraulic method involved locking the control surface actuating cylinder pistons at a predetermined position, and unlocking them at a definite time when missile control was initiated.

An effective hydraulic lock was designed into the system which contained electro-hydraulic servo valves with flapper-nozzle type hydraulic amplifiers. The differential between the system pressure and return pressure of the hydraulic system was used to actuate the lock. With this design, only one solenoid shut-off valve was required regardless of the number of actuating cylinders which were locked.

• **Lock Operation**—A 2-way, pilot-operated lock valve is installed in the cylinder body between the servo valve and the actuating cylinder. The volume of oil under high pressure (6800 psi caused by air loads,) is then a minimum, thus restricting the control surface travel because of fluid compression. Since the control surfaces are always set in one direction, only one lock valve is required in each actuating cylinder.

The lock valve spools have a small area at one end and a large area at the other. System pressure is

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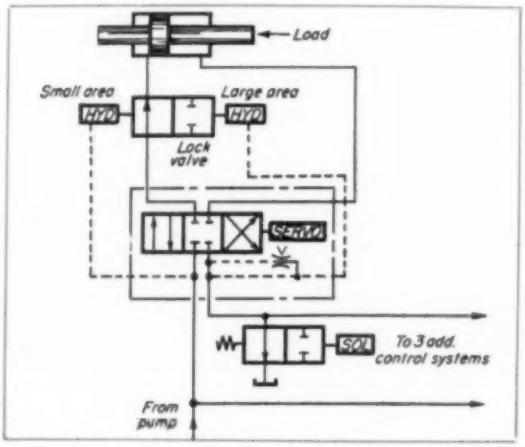
HYDRAULIC LOCK

always applied to the small ends and return line pressure is applied to the large ends of the valve spools. These hydraulic connections are made by drilled holes in the cylinder bodies.

One normally open, 2-way solenoid valve is installed in the main return line downstream from the servo valves which are arranged in parallel and manifolded to a single return line. With the solenoid valve de-energized (open), the return line is at reservoir pressure, and system pressure holds the locking valves in the open position. The servo control system is then operated in the normal manner.

When the solenoid valve is energized (closed) return flow is shut off. The flow through the nozzles



HYDRAULIC CIRCUIT has single solenoid valve for all lock systems. Closing the valve raises pressure in return line, because of flow through servo valve nozzles.

of the servo valves raises the pressure in the return line upstream of the solenoid valve to system pressure. Since the same pressure is now applied to both ends of the valve spools, they are moved to the closed position, locking the cylinder pistons and control surfaces at this position.

Any electrical signals applied to the servo valves during the locked phase will move the valve flappers, but cannot operate the actuating cylinder pistons. This prevents any erroneous electrical signals from actuating the control surfaces. The servo valves must be capable of withstanding system pressure in their return passages.

• **System Components**—The hydraulic system is powered by a gear pump driven by a directly connected electric motor. The motor is supplied with approximately 100 amperes at 28 volts d-c from a storage battery. The pump has an output of 6.5 cu. in./sec. (1.7 gpm) at 2100 psi. The 116-cu-in. reservoir contains a piston type, spring accumulator which maintains pump inlet pressure. A bleed valve, pressure and thermal relief valves, thermal switch, and piston positioning switch are also included.

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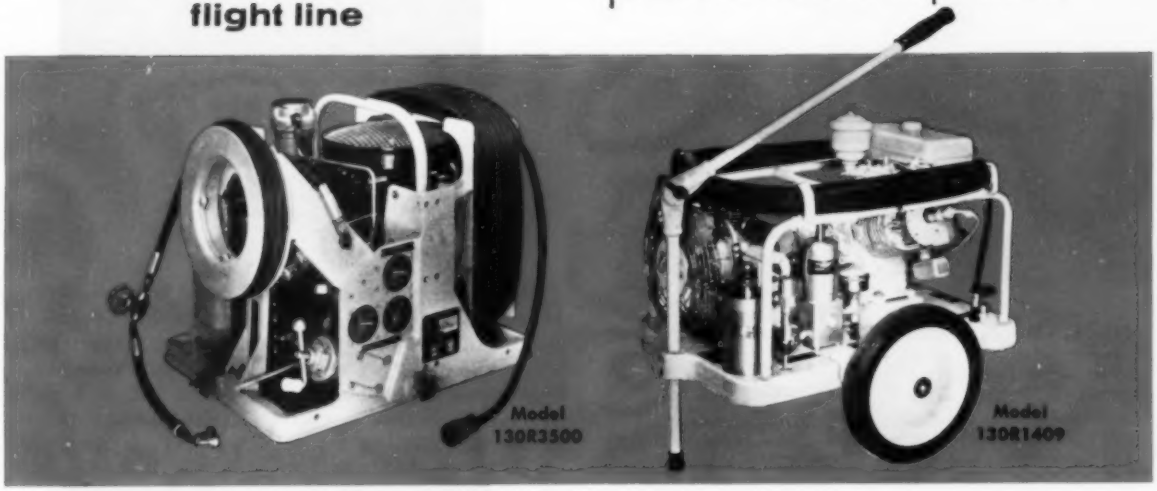

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FIG. 1. THREE HYDRAULIC systems are used on the Terrier missile launcher. The loading system uses a series-parallel system for simultaneous operation of two cylinders.

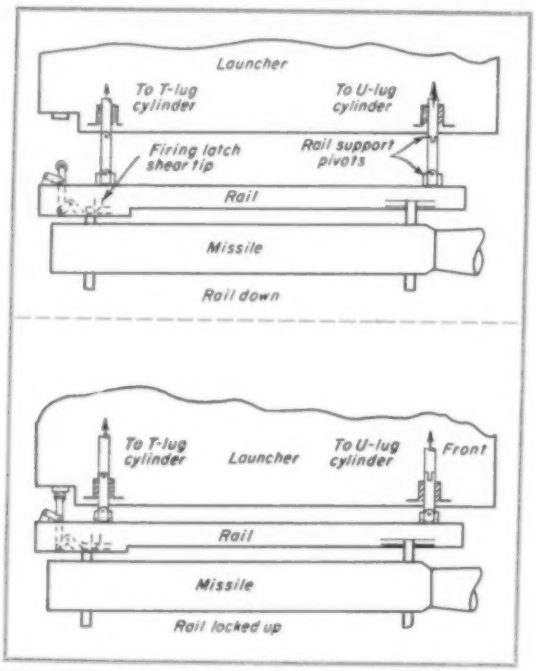

FIG. 2. PIVOTED ARMS let Terrier launcher rail move when the rail is lowered to make loading the missile easier. When the rail is raised, it is locked tightly to the launcher.

Series-parallel hydraulics helps launch missiles

• By Murray Sackson, *Section Manager*
and Howard Steinberg, *Project Manager, Missile Equipment Development Section, The W. L. Maxson Corp., New York, N. Y.*

GROUND-to-air Terrier missiles are launched by the Marine Corps from land-based, mobile launchers that can be towed just like a field gun, Figure 1. The launchers have three separate hydraulic systems. One is the train and elevation system, which uses hydraulic motors to rotate the launcher carriage and elevate the missile to any angle up to 60 deg in response to a radar tracking signal. Second is the bogie system to lower the launcher from its wheels at the launching site to give a firm steady base, and to raise it to the traveling position. The third, loading system, which will now be described in detail, does several things necessary to successful missile firing.

• **Loading System**—With the launcher in place, ready for loading, the first step toward firing a missile is to hang one on. A lift truck adaption, see page 111, hangs the missile on the launcher rail by engaging T and U lugs. The different lug shapes keep the missile from being put on backward. Since the lugs are a snug fit, and maneuvering a lift truck isn't quite precise enough to thread a needle, the rail must move a little during loading. But when the missile is launched, the rail must be held very rigidly.

Both are done by supporting the rail from two pivoted links that are lowered, or extended, during loading so the pivots can work freely. Each slot has a camming surface to make loading easier. Then, with the missile loaded, the arms and rails are raised. This draws the links into snug-fitting bushings in the launcher frame to hold the arms rigid, see Figure 2. The rail is raised and lowered by two hydraulic cylinders.

Hydraulics also rams, arms, and engages an electrical contact head that supplies signal and control

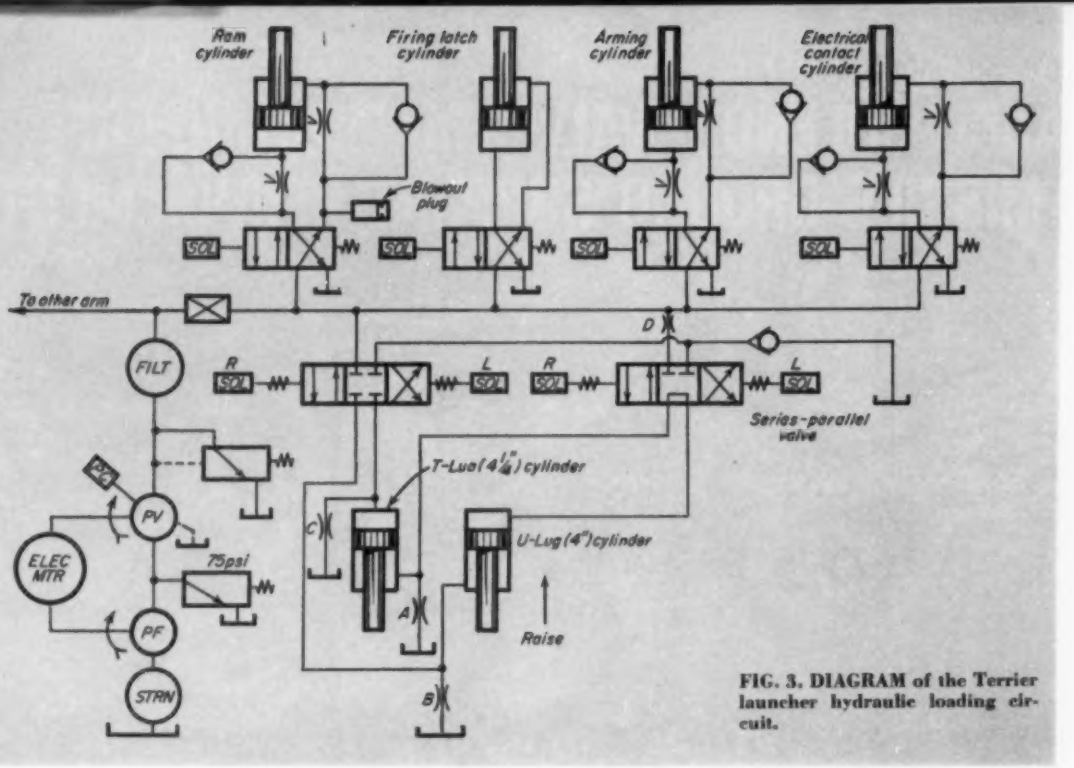

FIG. 3. DIAGRAM of the Terrier launcher hydraulic loading circuit.

voltages to the missile, and finally it latches the missile. With the rail and missile raised, and locked, a cylinder rams the missile to its correct fore and aft position on the rail. It is then latched in this position. Other cylinders then connect the warmup power, and arm it.

When the launcher is aimed and the firing key turned, the left contact head is raised, the latch is raised, the booster rocket is ignited, and away she goes. Two and one-half seconds later, the right-hand missile is launched. Rail cylinders are then extended to get ready for the next loading.

● **Hydraulic Circuit**—A fixed-displacement, 9.6-gpm, vane pump supercharges a variable-displacement, axial-piston pump to supply pressure to the system, Figure 3. Maximum hydraulic output is 9.6 gpm at 1175 psi. All cylinders except the T- and U-lug cylinders are controlled by 2-position, 4-way valves. Flow-control valves are used to control speed in both directions of the ram, contact, and arming cylinders. Flow controls are not used with the rail and latch cylinders because the fastest possible motion is wanted from them. The blowout plug connected to the head end of the ram cylinder lets go in case the mechanism is in the way of the missile being launched, and keeps the rail from being damaged.

The rail raising circuit uses two, 3-position, 4-way valves to give both series and parallel operation of these cylinders. Raising and lowering are done with the cylinders in series. The series-parallel valve stays centered for this part of the cycle. When the end of the cylinder strokes is neared, the series-parallel valve is shifted to parallel the cylinders and give a higher force to be sure that the cylinders are fully retracted or extended. On the raise stroke this force is also needed to hold the rail firmly against the launcher guide.

Because of mechanical design of the rail, the U-lug end must reach the up position slightly ahead of the T-lug end. To assure this, the U-lug cylinder has a head-end piston area a little smaller than the rod-end area of the T-lug cylinder. Internal mechanical uplocks are also used in each cylinder, to lock the pistons and the rail in the up position. Mechanically-actuated switches in the head end of each cylinder light indicating lights to show that the cylinders are locked up.

The fixed restrictions, *A* and *B*, which bleed the rod ends of the T- and U-lug cylinders to tank are there to let the rail be lowered by hand in case of electrical or hydraulic failure. The mechanical locks are released with a special tool, and the rail settles by its own weight. These restrictions also prevent pressure buildup due to valve leakage on the rod ends. With the rail down and both valves centered, this would cause the rail to rise.

Restriction *C* bleeds the head end of the T-lug cylinder to prevent pressure buildup there from valve leakage. This pressure, while not enough to release the lock and move the cylinder down, would cause the switch contacts to open and signal that the cylinder was unlocked.

Restriction *D* keeps the U-lug piston from dropping when the switch from series to parallel is made at the top of the raise stroke. This would happen because instantaneously, during valve shift, there is no resistance to flow in the line to the rod end of the T-lug cylinder. Since the pressure line also feeds the other valve this would result in zero pressure on the rod end of the U-lug cylinder if it were not for restriction *D*. ▼▼▼

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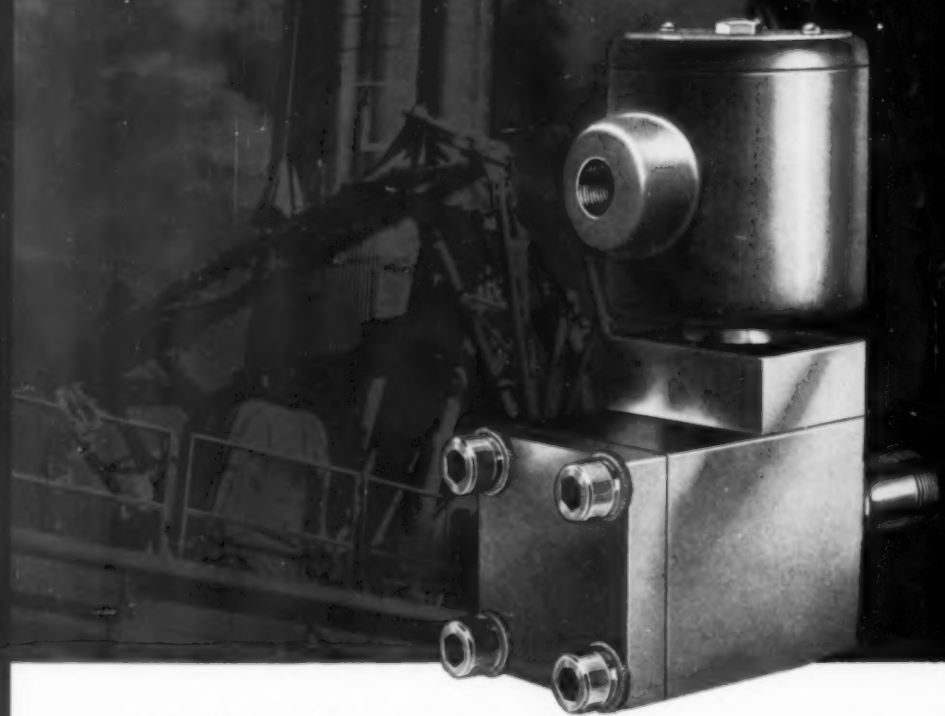

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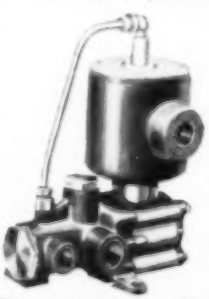
Two Way Valves . . . normally open or normally closed, easily handle fluids at pressures to 3000 psi, temperatures to -350° F. Valves are stainless steel with teflon discs; most sizes are available with AN connections (Main Illustration-Bulletin 8223X).

Three and Four Way Valves . . . are suitable for piloting cylinder operated valves. Three way valves are also utilized for controlling single acting cylinders, and diaphragms; four way valves are used for controlling double acting cylinders. Unique poppet type seats and discs assure tight seating at pressures to 750 psi, temperatures to -65° F. Valve shown below (Bulletin 8344X) is suitable for 4 way applications, or may be used for 3 way installations by plugging one cylinder connection.



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For additional information on ASCO Solenoid Valves for Missiles, write for Publication V5056.

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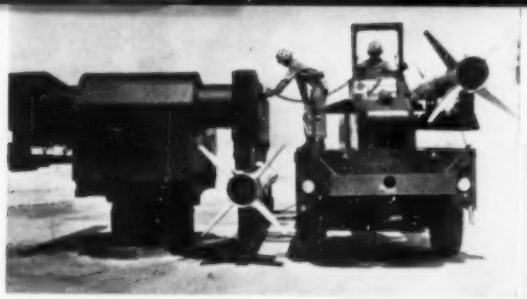

FIG. 1. TWIN MISSILE CARRIER for Terrier missiles is an adaption of the side-lift fork truck. Made for the Marine Corps. by Baker Industrial Truck Div., Otis Elevator Co., the truck picks up two missiles on their loading stands, carries them to the launchers, hangs the missiles on launcher rails, then takes the loading stands back to the missile dump.

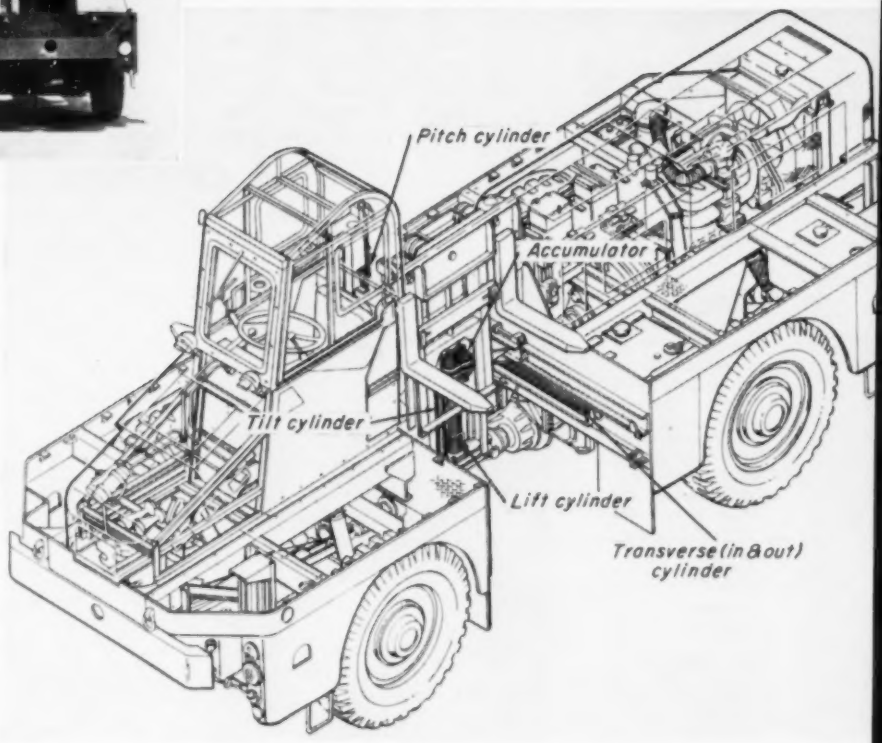

FIG. 2. LOCATION OF FORK operating cylinders on the Twin Missile Carrier.

Modified lift truck loads missile launcher

• By John Knarr, *Senior Development Engineer, Military Products, Baker Industrial Trucks, A Division of Otis Elevator Co., Cleveland, O.*

TERRIER missiles are brought from a storage area, or dump, to the launcher for firing. The launcher may be fixed or mobile. Since the missiles weigh about 2500 lb each, it takes some sort of a truck to move them. The truck used by the Marine Corps. is a modification of the side-lift fork truck used in industry.

• **What It Does**—The Twin Missile Carrier, Figure 1, picks up two missiles, one on each side; carries them to the launcher, and then hangs them on the launcher rails. Both fork lift mechanisms are identical. To pick up the missile on its supporting frame, or loading stand, from the ground at the dump, the forks are lowered and extended into openings in the stand. The stand is then clamped to the forks. Forks are then tilted and raised above the level of the truck frame. Forks, loading stand, and missile are now moved inboard so the missile doesn't stick out.

The forks can also be pitched. That is, the front fork may be raised higher than the rear fork, or vice versa, to line the forks up with the openings in the loading stand. This pitch movement also comes in handy in hanging the missile on the launcher. U and T-shaped lugs must be engaged on the launcher rail. All the lifting, tilting, pitching, and in-and-out motions are hydraulically powered.

• **Hydraulic System**—Beside moving the loading forks, hydraulics is used for steering and stabilizing.

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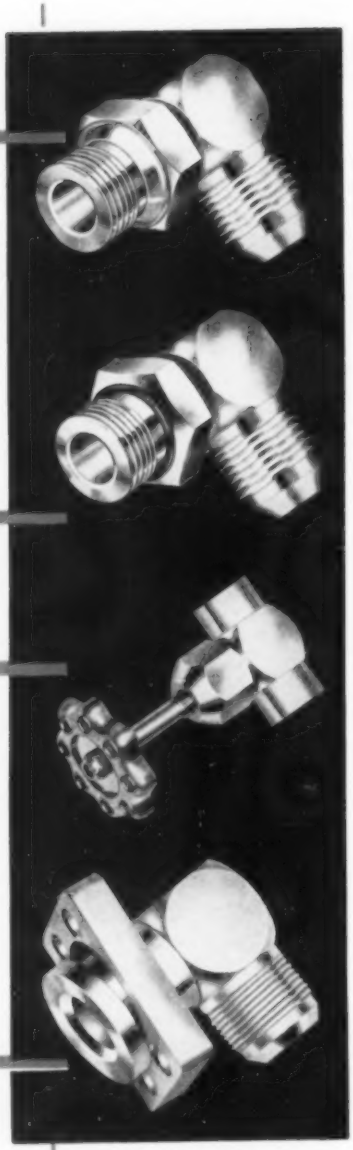

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The two stabilizing cylinders are extended to bear against the ends of the front axle, which is pivoted at the center of the frame. This keeps the truck bed from tipping when the load is picked up. The solenoid pilot valve to control these cylinders is always energized by a limit switch to stabilize the truck when the forks are extended. There is also a manual switch which the operator can use at any time to energize the valve for stabilization.

A dual pump with two 5-gpm sections powers all motions but steering. The power steering system has its own pump. One 5-gpm pump section supplies oil to the stabilizing cylinders and the pitch, tilt, transverse, and hoist cylinders, and supplies pilot pressure. The other 5-gpm pump section powers the hoist and transverse cylinders when they are automatically cycled by solenoid-hydraulic valves.

Automatic cycling through the raise-in or out-down motion lets the trip to the launcher or back to the dump start sooner. The operator starts the cycle by pushing a control button on the instrument panel, and then he is free to give all his attention to driving the truck. When one cylinder reaches the end of its stroke, a limit switch starts the other. At the end of the cycle, another limit switch shuts off the moving cylinder.

An accumulator is connected to each hoist cylinder to absorb shocks. During the trip to the launcher, this cylinder is extended. With the cylinder ports blocked the way they are, the missile bouncing on the forks might be damaged and could cause a dangerous pressure rise in the cylinder and lines. A relief valve might be used to limit pressure, but it would let the forks drop a little each time shock pressure opened it. This way, shocks compress the nitrogen in the accumulator, pressure rises just a little, and the fluid pushed into the accumulator flows back to the cylinder to return it to its proper position as soon as the shock is over.

Operating pressure for this system is 1200 psi. Strokes of the transverse and hoist cylinders are 41-½ and 72 in., respectively. Pitch and tilt are ±5 deg. Lifting capacity of each side is 5000 lb. ▼▼▼

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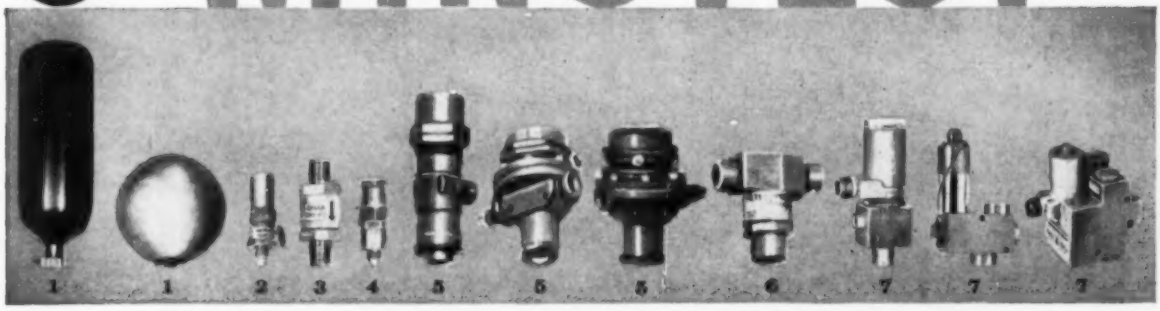

Left to right: **1** Containers (5,000 psi), **2** Relief Valve, **3** Check Valve, **4** Priority Valve, **5** Pressure Reducers, **6** Filter, **7** Solenoid Valves.

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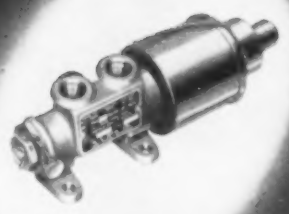
CIRCLE 77 ON TIME-SAVER CARD

SOLENOID VALVES



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AVIATION NEWS

from the fluid power field

The Hydrodyne Corp., North Hollywood, Calif., has added chief engineers to two of its divisions, **Donald Z. Erle** as chief engineer on fluid control devices, and **Richard E. Tisch** to head up the Skinner Seal Division. Earle formerly in charge of the hydraulic engineering group at Bendix Pacific has developed many hydraulic and pneumatic components for aircraft and missiles. Tisch was vice-president of product development, Minnesota Rubber Co. and has had over 10 years experience in high temperature sealing problems.

How the Aircraft and Missile Industries Buy . . . is the title of a one-day seminar sponsored by **Aeronautical Procurement** magazine in principal cities. They're meant to aid those who sell to the aircraft and missile industry by analyzing tricky procurement and purchasing procedures.

Louis J. DeRose, foremost authority on aircraft and missile procurement and head of DeRose and Associates, New York will head the seminars.

Program: Weapon Systems procurement; Objectives of aircraft and missile procurement, and how they affect salesmen; Methods and techniques of aircraft and missile procurement for salesmen; Variations in buyer-seller relationship; What salesmen should know about procurement trends in the aircraft-missile business.

The seminar is mainly for sales executives and their staffs. Fee: $25 per person, or $15 per person for groups of 5 or more from the same company. Information on when the seminar will be conducted in your city, together with reservations, can be obtained from **Aeronautical Procurement,** 812 Huron Rd., Cleveland 15, Ohio.

Airaterra Inc., Glendale, Calif., has named **Robert P. Thompson** as asst. chief engineer and **Richard C. Crane** as project manager in the sales department. Thompson had been chief engineer of the Frebank Co., Glendale, Calif. Crane served in sales liaison at Hydro-Air Inc., Burbank, Calif.

Richard C. Crane
Airaterra Inc.

Robert P. Thompson
Airaterra Inc.

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with a nominal resistance of 200 ohms. It has an output of approximately 15 millivolts full scale on open circuit with 3 volts excitation. Ambient temperature limits: —100 to 275 F.—*Statham Instruments Inc., Los Angeles, Calif.*

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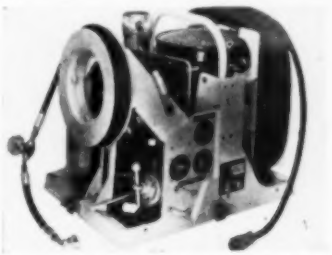

light-weight and low in cost. Deliver 2 to 4 cfm at 50 to 3000 psi. Adjustable pressure regulator. Assembly includes moisture separator, chemical drier, air reservoir and 13 ft of air hose. Gages are protected by gage savers. Has hour meter to record time in operation.—*The Cornelius Co., Minneapolis, Minn.*

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Continued on page 118

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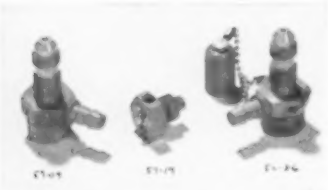

twist cap. On the twist cap model the valve automatically shuts off when the cap is released. They are used for bleeding air from filter housings, reservoirs, and hydraulic systems at pressures to 5000 psi and temperature to 400 F. Overall length .82 in.—*Arkwin Industries Inc., Westbury, N. Y.*

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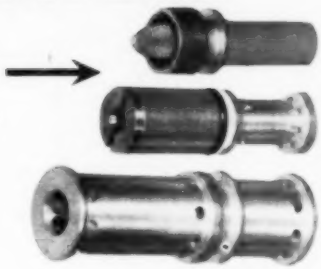

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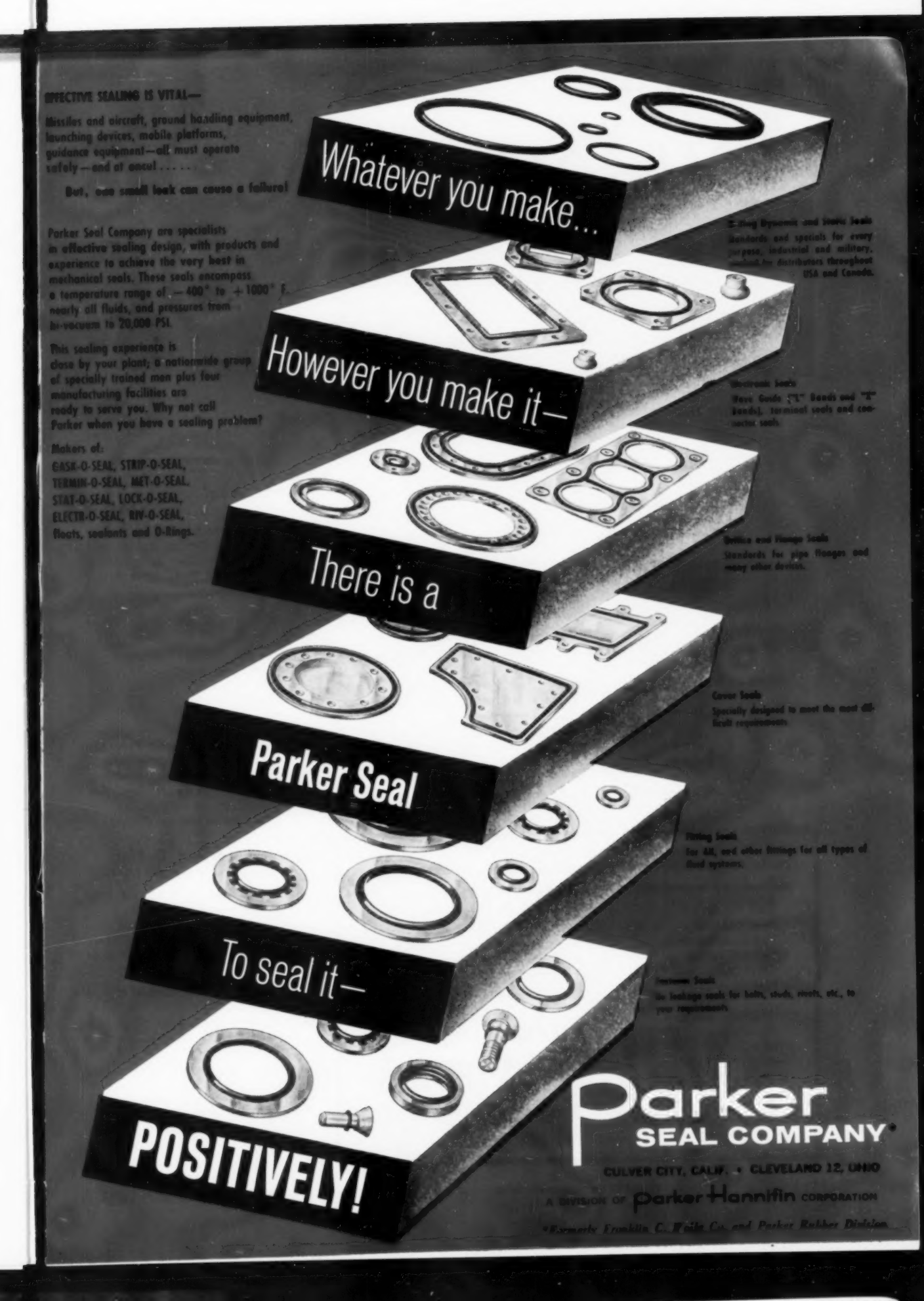
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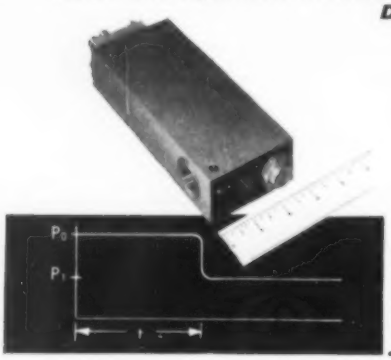
. . . designed and manufactured to customers' specifications for GROUND HANDLING EQUIPMENT, MISSILES and AIRCRAFT.

Automatic Hydraulic Pressure Dropping-Time Delay Valve

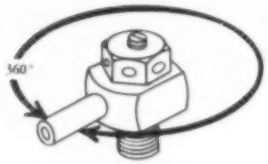


combines the function of six valves in a single body.

- Simplifies system design.
- Saves fittings and lines.
- Reduces installation costs.

P_0: 1400-1600 psi
P_1: Adj. 150-600 psi
t: Adj. 3-8 sec.

Bleeder Valve



- Reduces fire hazard.
- Bleeds while system is under pressure.
- Confines and directs discharge.
- Burst pressure — over 14,000 psi.
- Off-the-shelf delivery.

Write for data sheet No. 104.

Fluid Regulators' wide range of custom-made components include:

- Flow Regulators
- Flow Dividers
- Sequence Valves
- Selector Valves
- Check Valves
- Pilot Checks
- Controllable Checks
- Relief Valves All Four Basic Types
- Restrictors
- Special Non-standard Types
- Combinations of Two or More Types in a Single Body.

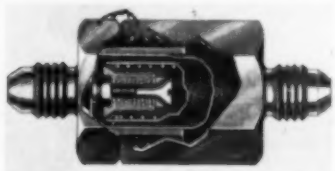
Designers And Manufacturers Of Hydraulic And Fuel Valves For Aircraft Missiles And Other Exacting Military Applications

Fluid Regulators CORPORATION

313 GILLETTE ST. • PAINESVILLE, OHIO • ELwood 2-3319

AVIATION COMPONENT DATA

pressures to 4000-psi. Operating temperatures —65 to 350 F ambient. Special units can be made for



700 F. Weight is 0.17 lb in aluminum and 0.42 lb in stainless steel. —*Aero Supply Mfg. Co., Inc., Corry, Pa.*

CIRCLE 507 ON TIME-SAVER CARD

Static Seal
. . . for 10,000 psi

Seal deforms with 25 to 175 ft lbs torque to become an integral part of fittings. Tests show sealing through —360 F to 1200 F de-

pending on use of aluminum, stainless steel or Inconel-X. Pressures to 10,000 psi. Called the Natorq they may be disassembled repeatedly.—*Navan Products Inc., Los Angeles, Calif.*

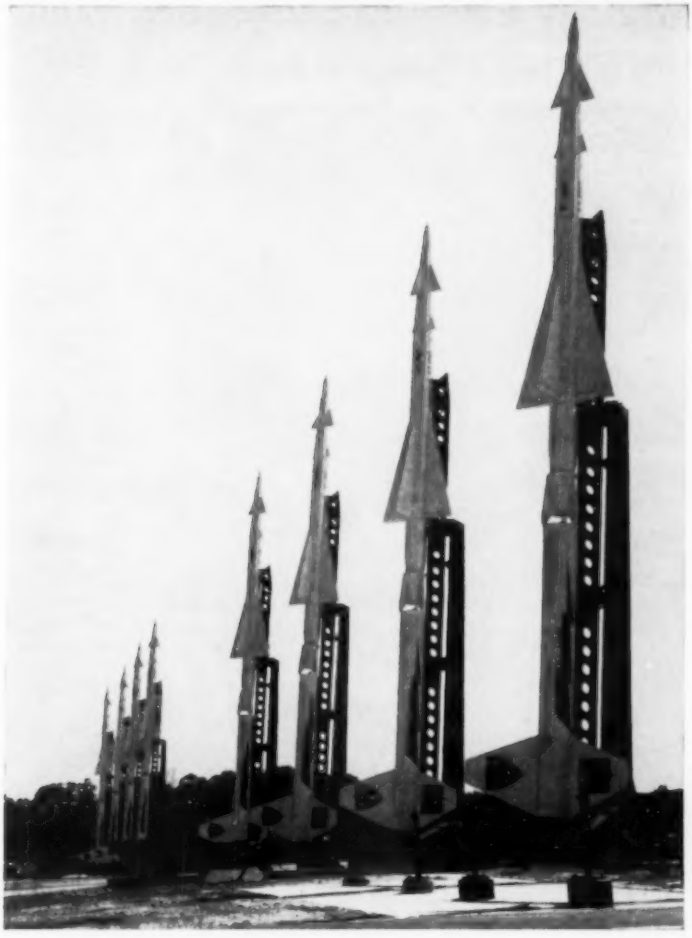
CIRCLE 508 ON TIME-SAVER CARD

New Seal and O-Ring
. . . gives low breakout friction

Kapseal is trade name for new Teflon boot developed to give positive sealing with low breakout friction. It eliminates welding effect noted in simple elastomeric seals

after long storage. Available in two styles to give a friction surface either on the ID or OD. Standard size range is .125 ID to 7.750 ID for KIN and .250 OD to 7.750 OD for KEX. They match standard ARP

Continued on page 122



New job for HOUGHTO-SAFE fluids

. . . where hydraulic safety and dependability are absolute "musts" for missiles and men

• One of the things that helps produce these dramatic moments is hydraulic equipment—moving the missile, setting it up, and holding it while it is readied for flight.

As in everything else in the world of missilery, only the best in hydraulics is good enough. That's why you'll find Houghto-Safe fire-resistant hydraulic fluids in many such critical military and defense applications.

And this same safety and dependability are your goals in industry too. Houghton can help you get both. Its fire-resistant hydraulic fluids are available for many different applications, in water-glycol, phosphate-ester and oil-emulsion types.

You can specify Houghto-Safe with confidence, because it is backed by years of hydraulic experience and complete engineering service. To obtain this service, simply give us the conditions under which the fluid is to be used. You will get unbiased recommendations, with no obligation. Write E. F. Houghton & Co., 303 West Lehigh Avenue, Philadelphia 33, Penna.

HOUGHTO-SAFE

. . . a product of

E. F. HOUGHTON & CO.

PHILADELPHIA • CHICAGO • DETROIT • SAN FRANCISCO

Ready to give you on-the-job service . . .

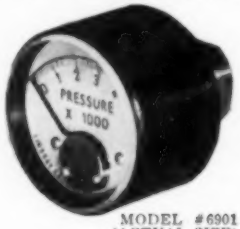
CIRCLE 66 ON TIME-SAVER CARD

New high pressure gauge passes 25 G "torture test" with ease

This photograph shows vibration testing of RMC-Lindsay gauges on the 3200 force pounds Calidyne Vibrator—1 to 25 G output, amplitude .0001 to .20, cycling frequencies to 2,000 cps. Pressurizing and testing are uniquely accomplished so as to parallel actual installation conditions. Complete test reports are available on request.

RMC-LINDSAY GAUGE

already checked out in Atlas missile and B-52



MODEL #6901
(ACTUAL SIZE)

The Atlas ICBM and B-52 bomber are two of the newer space age vehicles to use the RMC-Lindsay high pressure gauge. In both laboratory test and actual use, this gauge has met all requirements with room to spare.

The RMC-Lindsay Gauge is a multiple-coil, helical bourdon tube type, restricted for over-pressure. The pointer is attached directly to the end of the coil, eliminating the use of linkages and pivots.

The helical bourdon element is, of course, not a new development. However, the RMC-Lindsay techniques in coiling, heat treatment, calibration and material specifications *are* new—and exclusive with RMC.

PRESSURE RANGE: Pressures in ranges 0 to 1,000 p.s.i. up to 15,000 p.s.i. with retard scales available. *OVERLOAD PRESSURE:* Nominal overload pressure factor of 2.0 times the maximum dial reading (higher factors available). *BURST PRESSURE:* Normally 3.0 times the maximum dial reading. TEMPERATURE: Not affected by temperatures up to 250°F. *VIBRATION:* Qualification test report available on pressure tests showing cycling, vibration, from 0 to 2000 cps. at 25 G's, and resonant frequency vibration tests at 25 G's. *SHOCK:* Data available on MIL-E-5272A shock test at 40 G's (satisfactorily drop tested up to 900 G's in special tests). *PULSATION:* Practically unaffected by line pulsations of 3% of the full dial reading. *ENDURANCE:* 10,000 cycles up to 250,000 cycles, depending on application. *ACCURACY:* Hysteresis friction and backlash are below readable limits. Absolute gauge accuracy to 1½% average, 1% when requested.

Whatever your high pressure gauge problems may be, why not let RMC engineering skill provide the answers. Write to either of the addresses below.

ROCHESTER MFG. CO. OF CALIFORNIA
98 Beacon Place, Pasadena, California

ROCHESTER MANUFACTURING CO., INC.
209-C Rockwood Street, Rochester 10, N. Y.

RMC
LINDSAY PRESSURE GAUGES

AVIATION COMPONENT DATA

O-rings. Provide effective sealing for: high frequency, low amplitude, high response mechanism; mechanisms which must operate the first time with minimum breakout friction; standby machinery which must operate freely after long periods of inactivity and long-life equipment where dismantling for seal replacement is costly. Patented by Bendix Aviation, license for manufacture has been granted to—*Minnesota Rubber Co., Minneapolis, Minn.*

CIRCLE 509 ON TIME-SAVER CARD

Hydraulic Pump
. . . for 60,000 rpm

Has 4 interchangeable pump cartridges. Pressures to 4000 psi and speeds to 60,000 rpm. Pumps

all hydraulic fluids. Positive gear clearances and pressure balanced. High volumetric and mechanical efficiency and low starting torque. Easy servicing by replacing cartridge. Capacities to 25 gpm.—*Adel Precision Products, Division of General Metals Corp., Burbank, Calif.*

CIRCLE 510 ON TIME-SAVER CARD

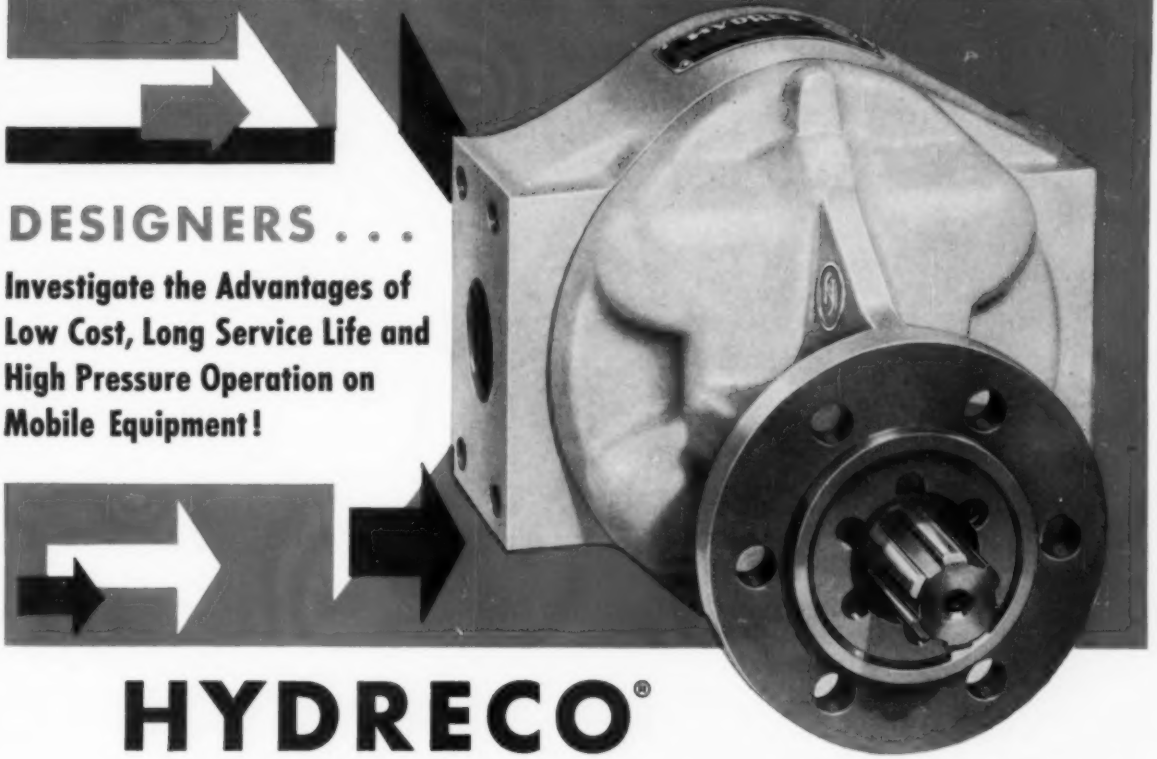
DC Motor
. . . for hydraulic pump

Motor was designed to drive a 3000 psi, 1-gpm pump for aircraft. Runs on 28 v dc and delivers 2 hp at 3000 rpm. Mounting flange AND—20001. Can be made with

foot or pad mounting. High power density from rectangular laminations. Patented brush holder gives even pressure over full range of brush for even power output.—*Hoover Electric Co., Columbus, O.*

CIRCLE 511 ON TIME-SAVER CARD

NEW HIGH PRESSURE FLUID POWER FOR MOBILE EQUIPMENT . . . .



DESIGNERS . . .

Investigate the Advantages of Low Cost, Long Service Life and High Pressure Operation on Mobile Equipment!

HYDRECO®

Series 2100 GEAR PUMPS

16 to 32 gpm at 1800 rpm
Operating Pressures to 2000 psi
40 gpm at 1800 rpm
Operating pressures to 1500 psi

Designed to cover a broad range of difficult applications, such as: heavy duty earth moving, road building and materials handling equipment. They feature four design advances that add up to . . . *More Duty Hours at Top Volumetric Efficiency and Minimum Cost.*

- Piloted housing and end covers eliminate shifting.
- Thrust bearing—to take axial thrust of hydraulic forces.
- Two-stage seal—runs cooler—lasts longer.
- Improved shaft bearings—tolerate increased loading.

The 2100 Series of HYDRECO Gear Pumps embraces heavy duty applications in the range immediately below that covered by the famous HYDRECO 3000K Series. Thus, with the 2100 and 3000K Series engineers have a broad selection of sizes in Hydraulic Pumps with established history of high performance and dependability.

Member NFPA

Write — for full information on Series 2100 and Series 3000K Gear Pumps.

HYDRECO DIVISION
THE NEW YORK AIR BRAKE COMPANY
9004-9 EAST MICHIGAN • KALAMAZOO • MICH.

HYDRECO Division
The New York Air Brake Company
9004-9 E. Michigan
Kalamazoo, Mich.

Please send me latest bulletins on HYDRECO Series 2100 and Series 3000K Hydraulic Pumps.

Name_____

Company_____

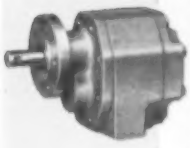
Address_____

City_____ Zone____ State_____

CIRCLE 70 ON TIME-SAVER CARD

ENGINEERED HYDRAULIC ASSEMBLIES

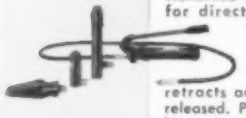
for all industry...



Engineering to your specifications . . . and for your special problems or Standard hydraulic units as low cost "shelf items"

Large inventories always on hand in a variety of hydraulic motors, pumps, cylinders and control valves. Moderate in price due to long runs for stock. High production facilities for non-stock items . . . ample equipment reserved for short runs.

Pushmaster Remote Control Single Acting Industrial Jacks



Hundreds of uses in industry for direct push-power for moving, pressing, bending, straightening, lifting. Ram retracts automatically when released. Packed in carrying kits or stands with wide selection of accessory tools.

Push and Pull Remote Control Industrial Jacks

All the advantages of the single-action Jack plus direct push and pull power with one ram. 4, 10, 20 ton capacities. Carrying kits or stands.

HEIN-WERNER Industrial Jacks

Capacities: 1½, 3, 5, 8, 12, 20, 30, 50 and 100 tons. Eight ton jacks and up may be equipped with pressure gauges.

BE PREPARED!

Hein-Werner Industrial RESCUE KITS

Small cost pays off thousands of times in an industrial accident. Tools clipped in-place for quick easy reach. Quick couplers on extensions save many minutes.

Hein-Werner CORPORATION
WAUKESHA, WISCONSIN

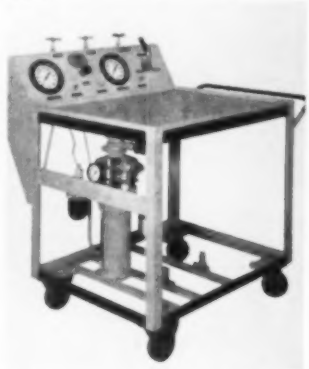
World's Largest Manufacturer of Hydraulic Jacks

NEW PRODUCTS

HYDRAULIC TEST STAND . . . is air operated

Designation: KC-854

Features: Stand is portable and may be taken to the system or component being tested. Plant air supply is the only utility needed.



Made with either single or dual outlets. On the dual outlet stand flow is controlled by a 4-way valve. This feature permits cycling of the component being tested.

Specifications: Size 37 in. long 38¼ in. high and 31 in. deep. Made in 3000, 5000, and 10,000 psi models.

Kahn and Company Inc.
Hartford, Conn.

CIRCLE 308 ON TIME-SAVER CARD

CLUTCH AND BRAKE VALVE . . . has safety feature

Designation: C

Features: Valve senses any malfunction within itself and locks out to prevent unsafe press operation. Can be re-cocked manually or by air pressure.

Construction: Two 3-way valves connected in parallel, each has a pilot valve operator and solenoid actuator. An attached lock-out unit supplies air to the pilot valve operators.

Operation: When the valve senses an unsafe condition, the lock-out unit cuts off air to the pilot actuators which stops the press at the end of its cycle. Before the press can be started again the valve must be re-cocked.

Ross Operating Valve Co.
Detroit, Mich.

CIRCLE 309 ON TIME-SAVER CARD

MOISTURE SEPARATOR . . . is float operated

Designation: Aqua-Jet

Features: Float triggers main valve to discharge moisture. Built-in felt cartridge keeps rust and grit from operating parts. Air line pressure blows out contaminants so particles can't settle on the soft seat.

Specifications: Made with metal or transparent bowl for air line sizes ¼ to 8 inch. Pressures 10 to 250 psi.

Wilkerson Corp.
Englewood, Col.

CIRCLE 310 ON TIME-SAVER CARD

SHAFT SEAL . . . for small oil pumps

Specifications: Type J-2

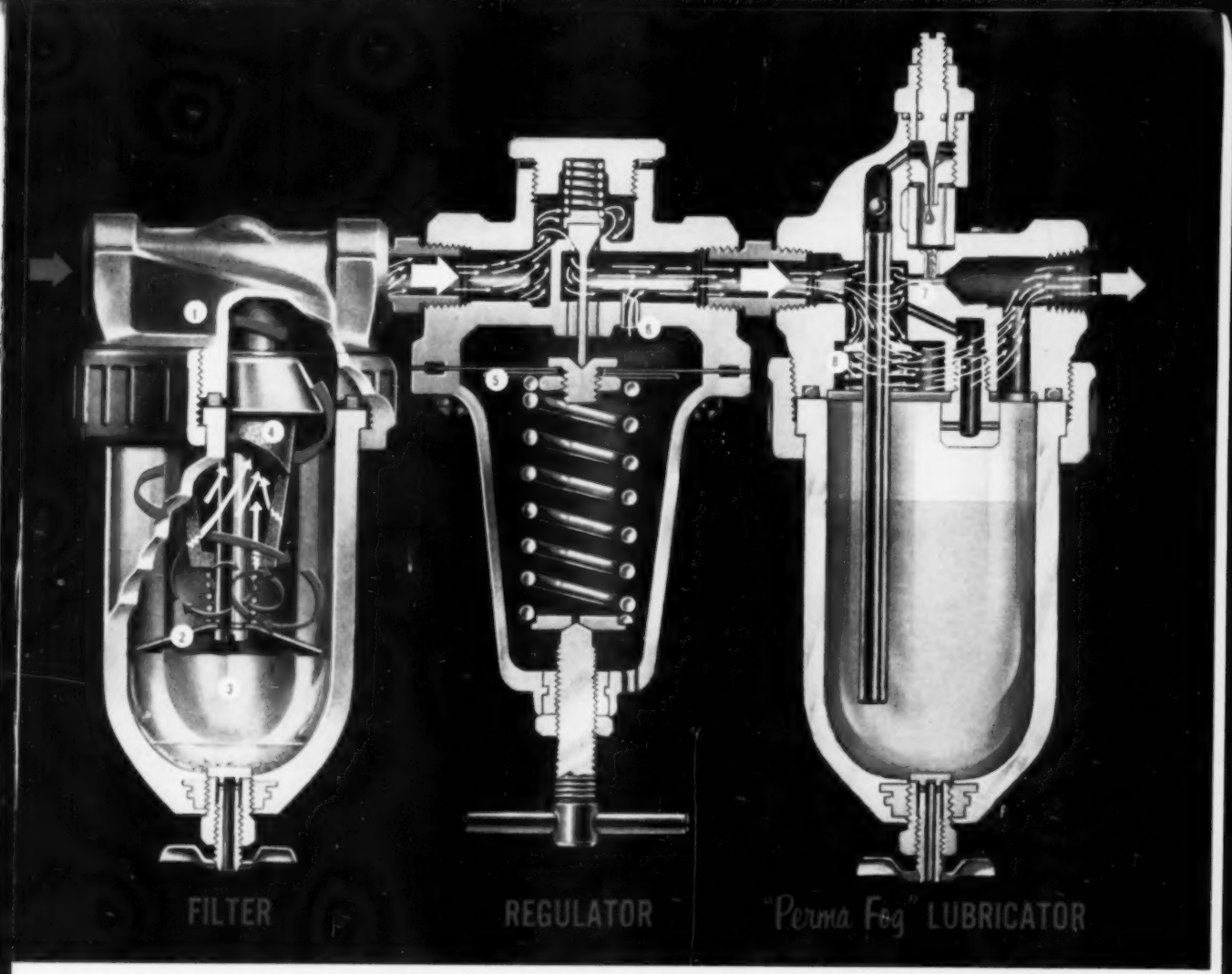
Features: Molded alloy carbon washer with large driving area provides positive contact and long life. Pressure is equalized over entire area to reduce wear. Will not score, seize or warp, and is not affected by temperature changes.

Specifications: Made in sizes for ⅝ and 1⅛ in. shafts for pressures to 60 psi.

Schweitzer Corp.
Indianapolis, Ind.

CIRCLE 311 ON TIME-SAVER CARD

Continued on page 126



Curved inlet ❶ directs incoming air in downward helical pattern. Larger impurities and condensate are "thrown out" by centrifugal action, collecting on bowl sides and spiraling downward past baffle ❷ into quiet chamber for draining off. Baffle traps sediment in quiet chamber ❸ and allows only dry air centrifugally cleaned of larger impurities to reach porous bronze filter element ❹ where finer particles are filtered out.

Diaphragm of large area ❺ is of BUNA-N—imparts extra sensitivity for response to even minute reduced pressure variations. Aspirator ❻ acts directly on diaphragm, providing instant compensation for fluctuating loads . . . assures precise control and stabilizes pressures reaching individual pieces of equipment.

High velocity venturi section ❼ provides ultra-fine, enduring atomization at air flow rates even less than 1 CFM. An exclusive by-pass feature ❽ provides lubrication at high flow rate without excessive pressure drop—wide range performance in **one unit.** Proof of lubricating efficiency assured because **all** visible metered oil is atomized.

NOW! Get this efficient TRIPLE LIFE-GUARD protection for your pneumatic equipment

A continuous supply of clean dry air . . . at a constant pressure . . . with just the right amount of lubrication provided at points of friction and wear. Air-operated equipment requires this three-way protection today; the Watts combination of pneumatic controls *assures* it.

You can expect *high efficiency* from the Watts line of advanced-design air line filters, regulators, and "Perma-Fog" lubricators. It's the *quality* assembly. Specialists in protection and control devices since 1875, Watts is setting new *standards* of efficiency in pneumatic operation.

WATTS

FILTERS
REGULATORS
LUBRICATORS

YOUR SAFE PROTECTION

Watts Regulator Company — Industrial Division — **6 Embankment Road** — **Lawrence, Massachusetts**

SEND FOR NEW CATALOG

It's a technical bulletin as well as catalog, describing the complete line of Watts Pneumatic Products. Complete engineering and operational data is furnished so that each page is, in fact, a specification sheet. Saves valuable time for the designer.

For hydraulic systems that must stay on the job . . .

Specify Flexon Hose

in rubber, synthetic or metal

FLEXON RUBBER AND SYNTHETIC HOSE AND COUPLINGS

Flexon Bulk Hose is offered in a complete range of types and sizes up to 2" for automotive, aircraft and industrial services.

Flexon Hose Assemblies are furnished with the broadest choice of standard and special fittings for low, medium and high pressures.

Flexon Reusable Couplings save time and money. All are equipped with Easy Grip Hex on stem for safe, speedy insertion into hose without the use of special mandrels.

Flexon Crimped-on Couplings are factory attached to provide complete hose assemblies to your specifications.

Flexon Dynalock Couplings are the ultimate in a clamp type reusable coupling.

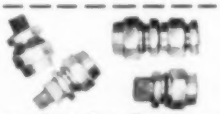
Flexon Adaptors, Unions & Connectors are available in a complete range of sizes and types for all services.

FLEXON METAL HOSE AND COUPLINGS

Flexon Corrugated Hose is the standard of the industry. Available in a variety of types in stainless steel, steel, bronze and other alloys.

Flexon Metal Hose Assemblies combine industry proven hose and couplings into a wide range of standard and special units.

Flexon Moisture Resistant Conduit combines a synthetic cover with a metal liner to form flexible electrical conduit.



Flexon Metal Hose Couplings are made in a complete range of sizes and styles for all types of Flexon Metal Hose.

Write for Bulletin C-100, covering rubber hose, and Bulletin 170, covering metal hose; no obligation.

• Flexonics Corporation is your Engineering Center for hose connections. As manufacturers of the broadest range of hose connectors and with over 56 years manufacturing experience, Flexonics is particularly well qualified to help you in your application problems. Whenever you have a problem that may be solved by the use of hose, let Flexonics Application Engineers assist you. Just send an outline of your requirements.

Flexonics Corporation

HOSE DIVISION
G-42

Mr. Flexon identifies products of Flexonics Corporation that have served industry for over 56 years.

1385 S. Third Avenue • Maywood, Illinois

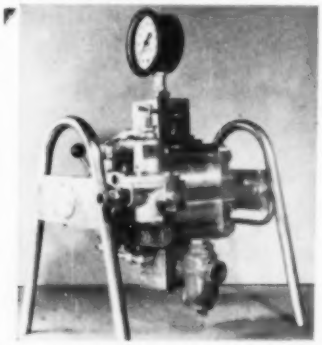
In Canada: Flexonics Corporation of Canada, Ltd., Brampton, Ontario
Manufacturers of metal and rubber hose, expansion joints, metallic bellows and aircraft components.

NEW PRODUCTS

HYDROSTATIC TEST UNIT . . . is air operated

Designation: 5-TU

Operation: Can be used for either water or oil testing. Requires 80 psi air pressure to build up 5000 psi hydraulic pressure. Output pressure is controlled by a regulator in



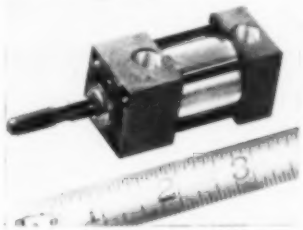
the air input line. Air enters the operating cylinder of the unit and causes the opposed plungers to build up the required test pressure. Pressure drop due to leakage is automatically recovered. It will maintain test pressure for any length of time required.

Logemann Bros. Co.
Milwaukee, Wis.

CIRCLE 312 ON TIME-SAVER CARD

MINIATURE CYLINDERS . . . for air and hydraulics

Specifications: Made in ¾, 1, and 1⅛ in bore. Type A for 200 psi air or 750 psi hydraulic and type H for 2000 psi hydraulic. Heads, piston rods, and tie rods are black oxide treated. Type A has a brass



tube, type H a steel tube. Both use O-rings for static and moving seals and can be used with non-flammable fluids.

Control Line Equipment
Cleveland, Ohio

CIRCLE 313 ON TIME-SAVER CARD

Continued on page 129

TYPICAL SCHRADER SIMPLIFIED VALVE DESIGN

. . another reason why your air system installations will perform best.

A—Mounting holes always conveniently located.

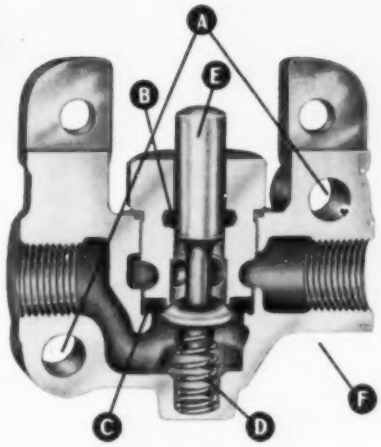
B—"O" rings used for surest airtight seal.

C—Oil-resistant synthetic rubber used in washers for positive leakproof seat.

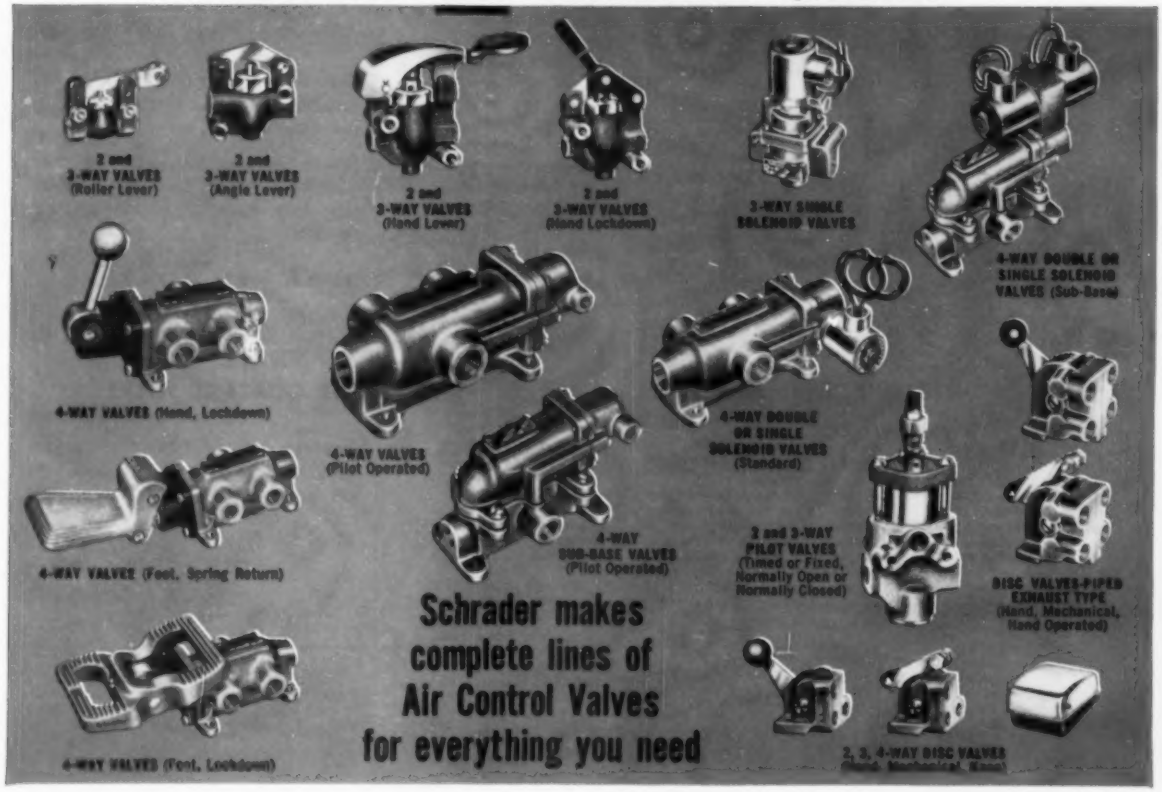
D—Stainless steel springs: rust resistance, longest service life.

E—Sturdy plated plungers, quick acting, smooth-operating.

F—All parts designed for greatest air flow, longest life and simplicity of replacement and interchangeability.



INSIDE EVERY SCHRADER VALVE YOU CAN SEE SCHRADER QUALITY


2 and 3-WAY VALVES (Roller Lever)
2 and 3-WAY VALVES (Angle Lever)
2 and 3-WAY VALVES (Hand Lever)
2 and 3-WAY VALVES (Hand Lockdown)
3-WAY SINGLE SOLENOID VALVES
4-WAY DOUBLE OR SINGLE SOLENOID VALVES (Sub-Base)
4-WAY VALVES (Hand, Lockdown)
4-WAY VALVES (Pilot Operated)
4-WAY DOUBLE OR SINGLE SOLENOID VALVES (Standard)
4-WAY VALVES (Foot, Spring Return)
4-WAY SUB-BASE VALVES (Pilot Operated)
2 and 3-WAY PILOT VALVES (Timed or Fixed, Normally Open or Normally Closed)
DISC VALVES-PIPED EXHAUST TYPE (Hand, Mechanical, Hand Operated)
4-WAY VALVES (Foot, Lockdown)
Schrader makes complete lines of Air Control Valves for everything you need
2, 3, 4-WAY DISC VALVES

Plus hundreds of Air Cylinders and accessories for every need

Send for Schrader Catalog on full line of air control products.

Schrader® a division of SCOVILL

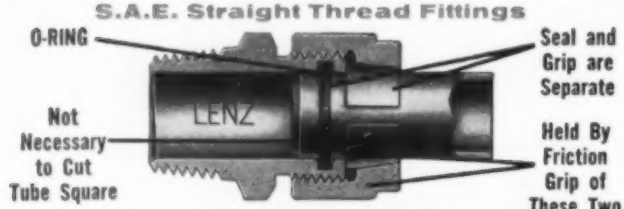
A. SCHRADER'S SON • *Division of Scovill Manufacturing Co., Inc.*
456 Vanderbilt Avenue, Brooklyn 38, N. Y.

QUALITY AIR CONTROL PRODUCTS

LENZ "O-RING" a famous name in J.I.C. Approved

TUBE FITTINGS

• NOW in Tapered or S.A.E. Straight Thread Fittings



PATENTED • PATENTS PENDING

NO METAL TO METAL SEAL! NO EXACT TUBE LENGTH NECESSARY!

Lenz fittings seal with standard, stock O-Rings. At zero pressure, the initial compression furnishes necessary sealing force . . . the higher the pressure the tighter the seal. Every joint becomes a union!

LENZ Fittings and Connections For any Piping Application

Lenz fittings pay for themselves, reduce installation and maintenance costs. Only a hacksaw and file needed . . . no periodic tightening . . . remain leakproof and reusable. For hydraulic, air and vacuum systems.

A Complete Line of Fittings and Accessories

PIPE FITTINGS

A complete line of connectors, elbows, crosses, tees, bushings, couplings, nipples and plugs . . . Full range of sizes for every piping need.

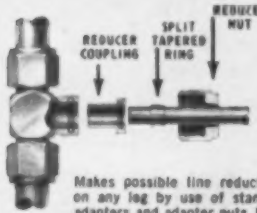
REUSABLE HOSE FITTINGS

Perfectly matched hose assemblies . . . a full line of re-usable fittings and hose lengths in low, medium and high pressure ranges. High, uniform quality.

AIR BLEEDER VALVES

Compact, functional . . . only two metal parts . . . no packings. Maintain maximum operating efficiency by eliminating air from lines.

REDUCER COUPLINGS



Makes possible line reductions on any leg by use of standard adapters and adapter nuts. Eliminates large inventory of special fittings and possibility of obsolescence from engineering changes. Full range of sizes.

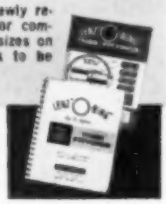
3-PIECE 37° FLARED FITTINGS

A complete line of connectors, elbows, crosses, tees and couplings in full range of sizes for every piping need.

OTHER LENZ PRODUCTS

Hydraulic Tubing
Industrial Hose
Stems & Joiners
Deburring Cutters
Tube Cutters
Tube Benders

Free! Write for newly released LENZ catalogs for complete product line and sizes on above products . . . ask to be put on our mailing list.



LENZ COMPANY

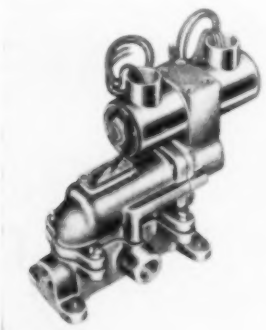
3303 Klepinger Road
Dayton 1, Ohio
Phone: CRestview 7-9364

CIRCLE 00 ON TIME-SAVER CARD

NEW PRODUCTS

FOUR-WAY AIR VALVES . . . single or double solenoid

Features: Poppet design. Stainless steel springs. Seals are oil resistant. Each valve tested before shipment.



Sold with or without subbase. Adjustable and non-adjustable timing cams available.

Specifications: For 110, 220, or 440 v ac continuous or intermittent duty. Sizes ¼, ⅜, ½, and ¾ in. NPT.

A. Schrader's Son
Division of Scovill Mfg. Co. Inc.
Brooklyn, N. Y.

CIRCLE 204 ON TIME-SAVER CARD

AIR CONTROL VALVE . . . for gun welders

Features: Mounts directly on the gun and gives fast response. Is compact which helps when moving the welder in close spaces. Needs only one air supply hose.

Valve is mounted on an adapter plate which bolts on gun.

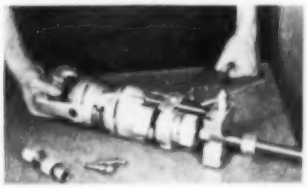
Construction: Made of aluminum for light weight and corrosion resistance. Solenoid coils are for ac or dc and guaranteed for the life of the valve. Valve stem is hard-

coated aluminum with O-ring packing.

Valvair Corporation
Akron, Ohio
CIRCLE 205 ON TIME-SAVER CARD

POWER FLARING TOOL
. . . is portable

Features: Flares fully annealed steel and stainless steel tubing in sizes to ¾ in. with wall thicknesses to 10 percent of tube diameter. Separate ball-cones are used for each tube size. May be clamped in a bench vise or held in



the hands. Uses a heavy-duty gearhead electric motor 110 v, ac or dc. Ball and roller bearings are used with permanent lubrication. Frame is cast aluminum for high strength and light weight.

Parker Fittings & Hose Div.
Parker-Hannifin Corp.
Cleveland, Ohio
CIRCLE 314 ON TIME-SAVER CARD

AIR LINE FILTERS
. . . have metal bowls

Features: Filters were designed for air lines where temperatures reach 300 deg F and pressures to 250 psi. The metal bow models, furnished with automatic or manual

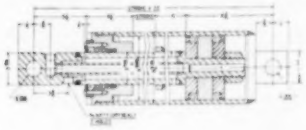
drain, embody a directional louver which creates a strong centrifugal action for removal of corrosive liquids from the air stream. Units are for ¾ and 1 in air lines and feature replaceable metal bowls.

Filters can be furnished with either 75, 64, or 25-micron filtering elements.

C. A. Norgren Co.
Englewood, Colorado
CIRCLE 315 ON TIME-SAVER CARD

HYDRAULIC CYLINDERS
. . . give variety of rod & head ends

Features: Assembled from interchangeable stock components.



Made in double and single acting. Special purpose cylinders are made with hollow piston rods. Hose connections are made to the rod which remains stationary. Cylinder barrel moves with work.

Specifications: Working pressures to 3000 psi. Maximum stroke 22 in. Effective areas to 50.26 sq in. Bore diameters to 6 in. Clevis and foot mounting are standard.

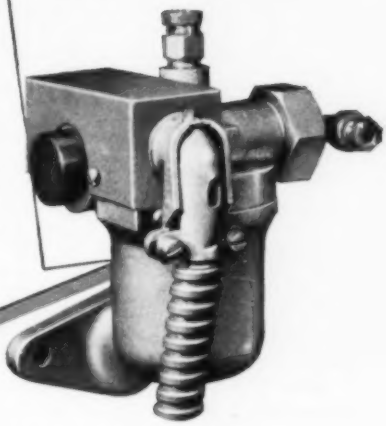
Wooster Division
Borg-Warner Corp.
Wooster, Ohio
CIRCLE 316 ON TIME-SAVER CARD

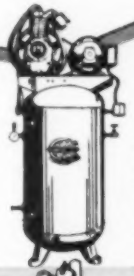
Continued on next page

DOWN TIME ABOLISHED!*

Revolutionary New Oil Monitor

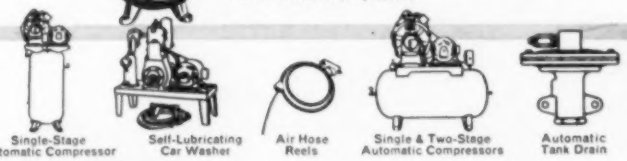
A micro switch makes it impossible for the compressor to start a new cycle unless enough oil is in the compressor crank case. No piston seizures possible!





Champion's line of air compressors from ½ to 10 hp, gasoline or electric powered. Slow speed means thermal efficiency—domed pistons and valves of Swedish razor blade steel.

* Except for belt trouble, which happens now and again with even the best compressors.



Single-Stage Automatic Compressor · Self-Lubricating Car Washer · Air Hose Reels · Single & Two-Stage Automatic Compressors · Automatic Tank Drain

CHAMPION
PNEUMATIC MACHINERY CO.
810 North Pleasant Street • Princeton, Illinois

This NUGENT FILTER will handle pressures to 3000 P.S.I.

Fig. 1555CP-0 Filter Fig. 1555E-0 Cartridge

Here's big news from the pioneer of fluid filtration. The Nugent Co. introduces the latest addition to their line of fine products . . . a completely new series of Laminated Fiber Disc Filters. Designated as 1555CP, they are designed for hydraulic and other high pressure applications.

Constructed for 3000 psi working pressure, they comply with the requirements of the ASME Code for Unfired Pressure Vessels. API or ASME code inspection and stamping is available.

Five sizes are available with capacities ranging from 1.5 GPM at 3 psi pressure drop to 47.6 GPM at 6 psi pressure drop when filtering 100 SSU viscosity mineral oil. For installations requiring larger capacity, the filters may be connected in multiple. Inlet, outlet and drain are located in the bottom of the filter.

For complete information on 1555CP filters, write today . . . or if your job is *RUSH*, phone ORchard 4-8121, Skokie, Illinois. Our engineers will help you.

ESTABLISHED 1897

REPRESENTATIVES IN PRINCIPAL CITIES

WM. W. NUGENT & CO., INC.

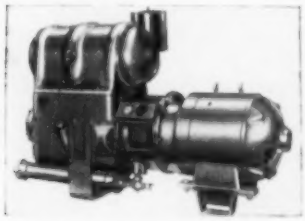
3432 CLEVELAND STREET, SKOKIE, ILLINOIS

OIL FILTERS • STRAINERS • TELESCOPIC OILERS
OILING AND FILTERING SYSTEMS • OILING DEVICES
SIGHT FEED VALVES • FLOW INDICATORS

NEW PRODUCTS

ROTARY AIR COMPRESSOR . . . is completely enclosed

Features: Lightweight and compact. Needs no special foundation. Can be bolted to any floor. Automatic safety switch and timer are



standard. No exposed belts or couplings. Made with air or water-cooled lube-oil coolers.

Specifications: The 100 hp unit has 490 cfm displacement. It delivers 420 cfm at 100 psi. At this pressure it has 93 brake hp. Shipping weight is 3800 lbs.

Davey Compressor Co.
Kent, Ohio

CIRCLE 317 ON TIME-SAVER CARD

FOOT SWITCHES . . . in watertight enclosures

Features: Made with or without guard over the treadle. Can be furnished with a latch to hold treadle down. Either one or two contact blocks, normally open or normally closed are available. The broad

treadle is easy to reach and is placed close to the floor to reduce operator fatigue. When two contact blocks are used they can be operated simultaneously or in two stages.

Specifications: Contact ratings are 6 amp at 110 v, 3 amp at 220 v, and 1.5 amp at 440 v ac. DC ratings are 0.4 amp at 115 v, 0.2 amp at 230 v, and 0.1 amp at 550 v.

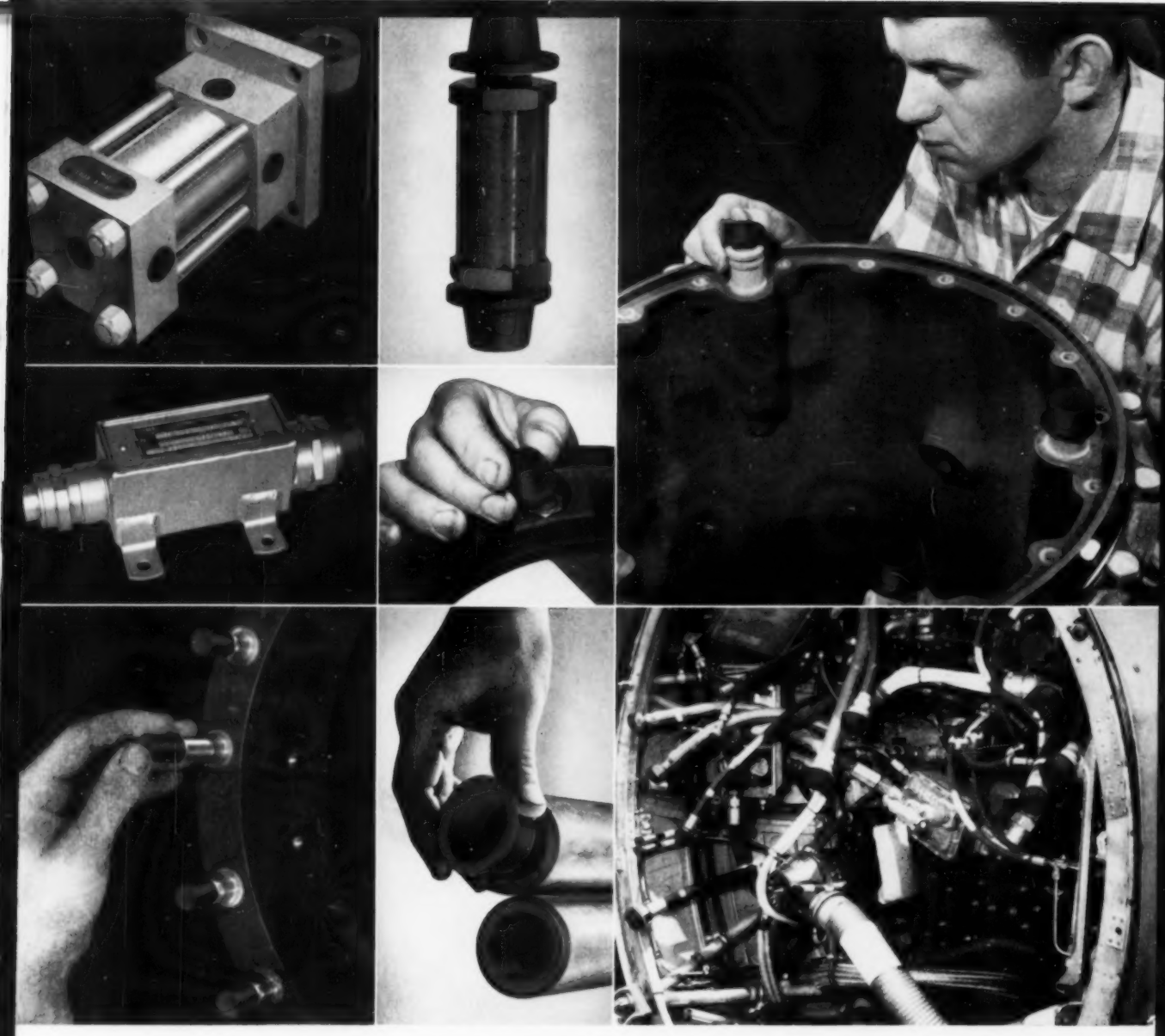
Allen-Bradley Co.
Milwaukee, Wis.

CIRCLE 318 ON TIME-SAVER CARD

Continued on page 132

CIRCLE 98 ON TIME-SAVER CARD

CIRCLE 110 →



chances are you'll find Caplugs ideal for your closure needs, too . . . they're made of tough, flexible Polyethylene . . . easy to apply and a cinch to remove . . . won't chip, break, shred or collapse . . . over 500 sizes in a dozen different styles now on the shelf.

Caplugs

QUICK, SLICK PROTECTION FOR PRODUCTS
IN PROCESS, STORAGE AND TRANSIT

GET THIS KIT FULL OF SAMPLES IN EXCHANGE FOR THE COUPON ATTACHED

CAPLUGS DIVISION, PROTECTIVE CLOSURES CO., INC.
2203 Elmwood Ave., Buffalo 23, N.Y.

Mail a free assortment of Caplugs, literature and prices to us, without obligation.

NAME _____ TITLE _____

FIRM _____

ADDRESS _____

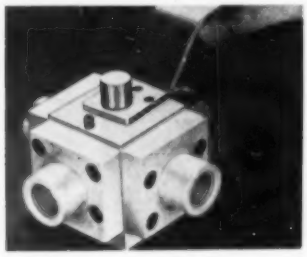
CITY _____ ZONE _____ STATE _____

NEW PRODUCTS

FOUR-WAY VALVE
. . . has low pressure drop

Designation: Spheroter

Features: Made in open and closed center and has high flow capacity. Metal-to-metal seals are both spring and pressure loaded. Can be operated at rated pressure with 7 lb torque on the end of a 7-in. handle. Each port is individually attached to the body and may be



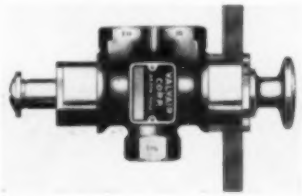
changed or serviced without special tools.

Specifications: Made in ¼, ⅜, and ½-in. for pressures to 3000 psi. Air or oil service.

Sarasota Precision Products
Sarasota, Fla.
CIRCLE 319 ON TIME-SAVER CARD

AIR VALVES
. . . for panel mounting

Features: Leak-free, unrestricted flow, and simplified mounting. One piece Navy M bronze body and chrome-plated stainless steel stem. Flow area through valve is equal to nominal pipe size.

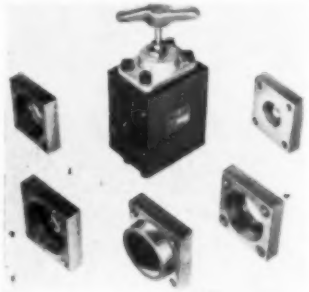


Specifications: Made in 2, 3, and 4-way types in sizes from ¼ to ¾ in. NPT. A choice of adapters permits use of various size valves in the same panel with uniform appearance. Control knobs are made in stainless steel and black or red plastic.

Valvair Corp.
Akron, Ohio
CIRCLE 320 ON TIME-SAVER CARD

THROTTLING VALVE
. . . for 10,000 psi

Features: One piece seamless body. Low torque under high line pressure. Valve body can be removed from the line without breaking



connections. Thirteen interchangeable port flanges. Made of aluminum or stainless steel. Meets all JIC standards.

Specifications: Flanges available in 1¼, 1½, and 2-inch. Operating pressure 7500 psi for aluminum and 10,000 psi in stainless steel.

Greer Hydraulics Inc.
Jamaica, N. Y.
CIRCLE 321 ON TIME-SAVER CARD

Continued on page 134

Lincoln AIR AND HYDRAULIC Cylinders

The answer to the increased demand for rugged, heavy duty air and hydraulic cylinders. Designed for the hardest usage in Steel Mill operation or for the hundreds of other modern cylinder applications that require dependable efficient service.

WRITE FOR NEW COMPLETE CATALOG

Lincoln MACHINE CO. INC.

P. O. Box 272 EDgewood 2-4689 Salem, Ohio

CITY ZONE STATE

USE ONE OF THESE TIME-SAVER CARDS...

...for more information on advertised products, new components, useful literature, etc. Just circle item number and drop in the mail.

New Products

Descriptions start on page 56

HYDRAULIC CYLINDERS 300
Hanna Engineering Works
QUICK COUPLING 301
Snap-Tite Inc.
SOLENOID CONTROL VALVES 302
C. B. Hunt & Son, Inc.
OIL FILTER 303
General Filters Inc.
FLEXIBLE COUPLINGS 304
Detroit Power Coupling Co.
AIR COMPRESSOR 305
Le Roy Division
HYDRAULIC FILTERS 306
The Rosean Co.
BALL VALVES 307
Jamesbury Corp.
HYDRAULIC TEST STAND 308
Kahn and Co.
CLUTCH AND BRAKE VALVE 309
Ross Operating Valve Co.
MOISTURE SEPARATOR 310
Wilkerson Corp.
SHAFT SEAL 311
Schwaltzer Corp.
HYDROSTATIC TEST UNIT 312
Logemen Bros. Co.
MINIATURE CYLINDERS 313
Control Line Equipment
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C. A. Norgren Co.
HYDRAULIC CYLINDERS 316
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POLYMIADE HOSE ASSEMBLIES 328
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OIL SUPPLY SYSTEM 329
The Cardwell Machine Co.
LINE FILTER 330
Marvel Engineering Co.
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Mechanical Products Corp.
FLARELESS TUBE FITTING 333
Chicago Forging and Mfg. Co.
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Automatic Switch Co.
PLUG VALVE 335
Hoke Inc.
OIL FILTERS 336
Wm. W. N[illegible] Co.
RELIEF VALVES 337
Fluid Controls Inc.
AIR-COOLED HEAT EXCHANGER 338
Niagara Blower Co.
AIR MUFFLERS 339
The Deltec Aids Co.
BLOWERS 200
Spencer Turbine Co.
DIRECTIONAL VALVES 201
Vickers Div. Sperry Rand Corp.

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ADVERTISERS

1	21	41	61	81	101	121	141	161	181	201	221
2	22	42	62	82	102	122	142	162	182	202	222
3	23	43	63	83	103	123	143	163	183	203	223
4	24	44	64	84	104	124	144	164	184	204	224
5	25	45	65	85	105	125	145	165	185	205	225
6	26	46	66	86	106	126	146	166	186	206	226
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9	29	49	69	89	109	129	149	169	189	209	229
10	30	50	70	90	110	130	150	170	190	210	230
11	31	51	71	91	111	131	151	171	191	211	231
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13	33	53	73	93	113	133	153	173	193	213	233
14	34	54	74	94	114	134	154	174	194	214	234
15	35	55	75	95	115	135	155	175	195	215	235
16	36	56	76	96	116	136	156	176	196	216	236
17	37	57	77	97	117	137	157	177	197	217	237
18	38	58	78	98	118	138	158	178	198	218	238
19	39	59	79	99	119	139	159	179	199	219	239
20	40	60	80	100	120	140	160	180	200	220	240

NAME _____

POSITION: _____

COMPANY: _____

PRODUCT MFG.: _____

STREET _____

CITY _____ ZONE ____ STATE _____

Do not use after 12-15-58

NEW PRODUCTS

300	305	310	315	320	325	330	335
301	306	311	316	321	326	331	336
302	307	312	317	322	327	332	337
303	308	313	318	323	328	333	338
304	309	314	319	324	329	334	339

FREE LITERATURE

400	405	410	415	420	425	430	435
401	406	411	416	421	426	431	436
402	407	412	417	422	427	432	437
403	408	413	418	423	428	433	438
404	409	414	419	424	429	434	439

AVIATION DATA

500	505	510	515	520	525	530	535
501	506	511	516	521	526	531	536
502	507	512	517	522	527	532	537
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12	32	52	72	92	112	132	152	172	192	212	232
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15	35	55	75	95	115	135	155	175	195	215	235
16	36	56	76	96	116	136	156	176	196	216	236
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504	509	514	519	524	529	534	539

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HIGH PRESSURE CHECK VALVE 202
Sealol Corp.
AIR AND OIL CYLINDERS 203
Hydro-Line Mfg. Co.
FOUR-WAY AIR VALVES 204
A. Schrader's Sons
AIR CONTROL VALVES 205
Valvair Corp.

Useful Literature

Descriptions start on page 62

SOLENOID VALVES 400
J. D. Gould Co.
OIL FILTERS 401
Bendix Filter Div.
CHECK VALVES 402
The Fairbanks Co.
ROTARY AIR MOTOR 403
Gardner-Denver Co.
SEAMLESS TUBING 404
Babcock & Wilcox
ENGINEERING DATA 405
Commercial Shearing & Stamping Co.
HYDRAULIC PUMPS 406
SC Hydraulic Engr. Co.
CAP SCREWS 407
Standard Pressed Steel Co.
VARIABLE DISPLACEMENT PUMPS 408
The Oilgear Co.
ELECTRICAL ENCLOSURES 409
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HIGH PRESSURE FILTER 501
Bendix Filter Div.
AIR COMPRESSOR 502
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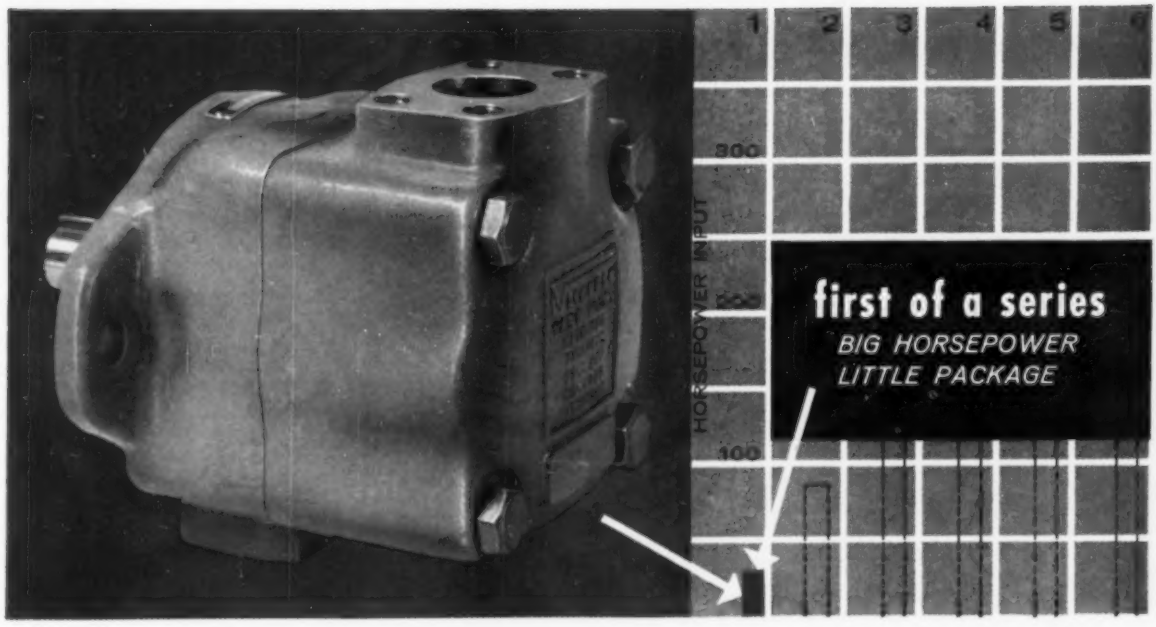
SEAL COMPOUND 503
Precision Rubber Products Corp.
BLEEDER VALVES 504
Arkwin Industries Inc.
RELIEF VALVE 505
Fluid Regulators Corp.
BRAKE VALVE 506
Hydra-Power Corp.
SERVO FILTER 507
Aero Supply Co.
STATIC SEAL 508
Naven Products, Inc.
NEW SEAL AND O-RING 509
Minnesota Rubber Co.
HYDRAULIC PUMP 510
Adel Precision Products
DC MOTOR 511
Hoover Electric Co.



NEW VICKERS® high performance vane pump

• high speed • high pressure • high efficiency • high service life

NEW COMPACT DESIGN . . . more than twice the horsepower of previous pumps in the same package size.

NEW VANE CONSTRUCTION . . . positive vane tracking at all speeds assures efficient operation at increased speeds and pressures.

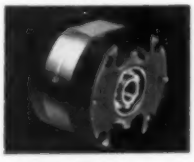
NEW SIZES not previously available . . . answers mobile equipment designers' need for greater hydraulic horsepower in limited space.

NEW PARTS INTERCHANGEABILITY . . . many common parts for single and double pumps (two pumps on the same shaft in one envelope). Lessens inventory requirements.

NEW 4-BOLT SAE FLANGE CONNECTIONS . . . will also accommodate user's 2-bolt flanges of the proper design.

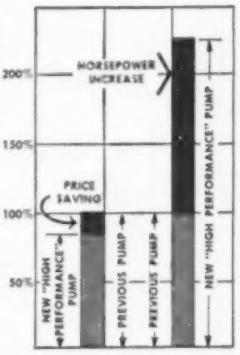
NEW 2-BOLT MOUNTING (SAE 1959 STD.).

NEW REPLACEABLE PUMPING CARTRIDGE . . . all wearing parts of pump are incorporated in one replaceable cartridge. Easy field replacement without removing pump from its mount. Cartridges available in kit form.



MORE HORSEPOWER PER DOLLAR. The graph at the right makes a revealing comparison between this new pump and a previous pump of the same rated delivery. The new Vickers "High Performance" pump provides more than *twice the horsepower* at *less cost* while shrinking package size from 200 to 112 cubic inches.

The complete line of "High Performance" pumps (both single and double) is being readied for release. Size range will accommodate your largest requirements. This first model of the series is available in three ring capacities; 12 gpm, 14 gpm, and 17 gpm as shown in table below.



Model Number	Delivery-GPM 1200 RPM 100 PSI	Delivery-GPM 2000 RPM 2000 PSI	Input Horsepower @ 2000 RPM 2000 PSI	Package Size†	Weight
2V12A-**10	11.8	17.8	25.5	L. 5⅜" W. 4⅝" H. 5¼"	26 Lb.
2V14A-**10	13.6	20.4	29.0		
2V17A-**10	16.6	25.2	36.0		

†Exclusive of Shaft Extension and Mounting Lobes

8050

Write for new illustrated Bulletin No. M5108 for further details and performance characteristics.

VICKERS INCORPORATED
DIVISION OF SPERRY RAND CORPORATION
Mobile Hydraulics Division
ADMINISTRATIVE and ENGINEERING CENTER
Department 1474 • Detroit 32, Michigan

Application Engineering Offices: • ATLANTA • CHICAGO • CINCINNATI CLEVELAND • DETROIT • GRAND RAPIDS • HOUSTON • LOS ANGELES AREA (El Segundo) • MINNEAPOLIS • NEW YORK AREA (Springfield, N.J.) PHILADELPHIA AREA (Media) • PITTSBURGH AREA (Mt. Lebanon) PORTLAND, ORE. • ROCHESTER • SAN FRANCISCO AREA (Berkeley) SEATTLE • ST. LOUIS • TULSA

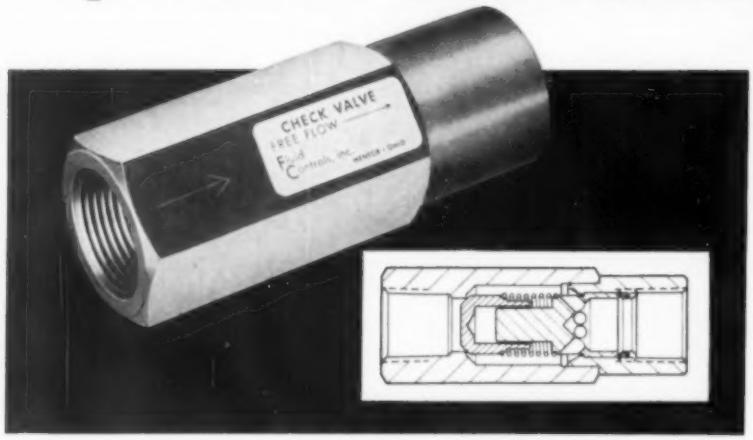
FACTORIES ALSO IN AUSTRALIA, ENGLAND, GERMANY and JAPAN
IN CANADA: Vickers-Sperry of Canada, Ltd., Toronto, Montreal and Vancouver

ENGINEERS AND BUILDERS OF OIL HYDRAULIC EQUIPMENT SINCE 1921

CIRCLE 141 ON TIME-SAVER CARD

CIRCLE 49 ON TIME-SAVER CARD

Dependable Check Valves



- Can't Stick Open
- Low Pressure Drop
- For Oil
- Copper Brazed Steel Bodies
- To 5000 P.S.I. Service
- Pipe Sizes ¼" thru 1¼"

Write for detailed specifications and prices.

Fluid Controls, inc.

Manufacturers of Hydraulic Valves and Devices

Relief Valves • Check Valves • Restrictor Valves
Needle Valves • Pilot Check Valves • Special Valves
Pressure Compensated Flow Regulators

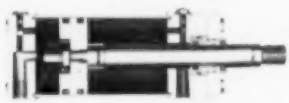
1284 N. CENTER STREET • MENTOR, OHIO

Member of Fluid Power Association

NEW PRODUCTS

AIR AND OIL CYLINDERS . . . in 11 bore sizes

Designation: R2



Features: Twelve mounting styles. All but clevis mount can be made double rod end. Rod ends can have internal or external threads. Pressure sensitive barrel seals. Hardened and chrome-plated piston rods. Metal-to-metal floating cushion at gland end. Extra long rod bearing and low friction rod seals. Cartridge type gland for easy removal.

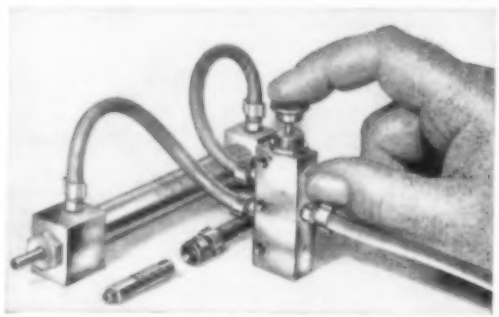
Specifications: Rated at 200 psi air and 500 to 2500 psi hydraulic, depending on bore size.

Hydro-Line Mfg. Co.
Rockford, Ill.

CIRCLE 203 ON TIME-SAVER CARD

Continued on page 137

NEW! MORE Powerful 9/16" MINIATURE AIR CYLINDERS · 4-WAY AIR VALVES · QUICK CONNECTS



NEW more powerful 9/16" bore spring return and double acting MINIATURE Air Cylinders to complement our widely used 3/8" bore cylinders, NEW 4-way Air Valve, Quick Connects, A.C. and D.C. Solenoids, fittings, mountings and other needed items to improve your automatic tooling and production devices or new end products. Made for MILLIONS of cycles of trouble-free operation! Modestly priced.

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Manufacturers of R. F. Coils, Electronic Equipment, Miniature Pneumatic Devices

CIRCLE 29 ON TIME-SAVER CARD

Stop Excessive Bearing Wear with Light-Weight Couplings

All flexible couplings operate in an unbalanced condition when coupling misaligned shafts. And when turning at 1750 rpm, each inch-ounce of unbalance produces a vibration-creating force of about 5½ lbs. Magnaloy couplings are made of a magnesium alloy weighing 80% less than steel, the common coupling material. Less weight means less vibration and less wear on equipment bearings. Write for the Magnaloy Catalog today.

DETROIT POWER COUPLING CO.

992 West Seven Mile Road • Detroit 3, Michigan

Series B

Series A

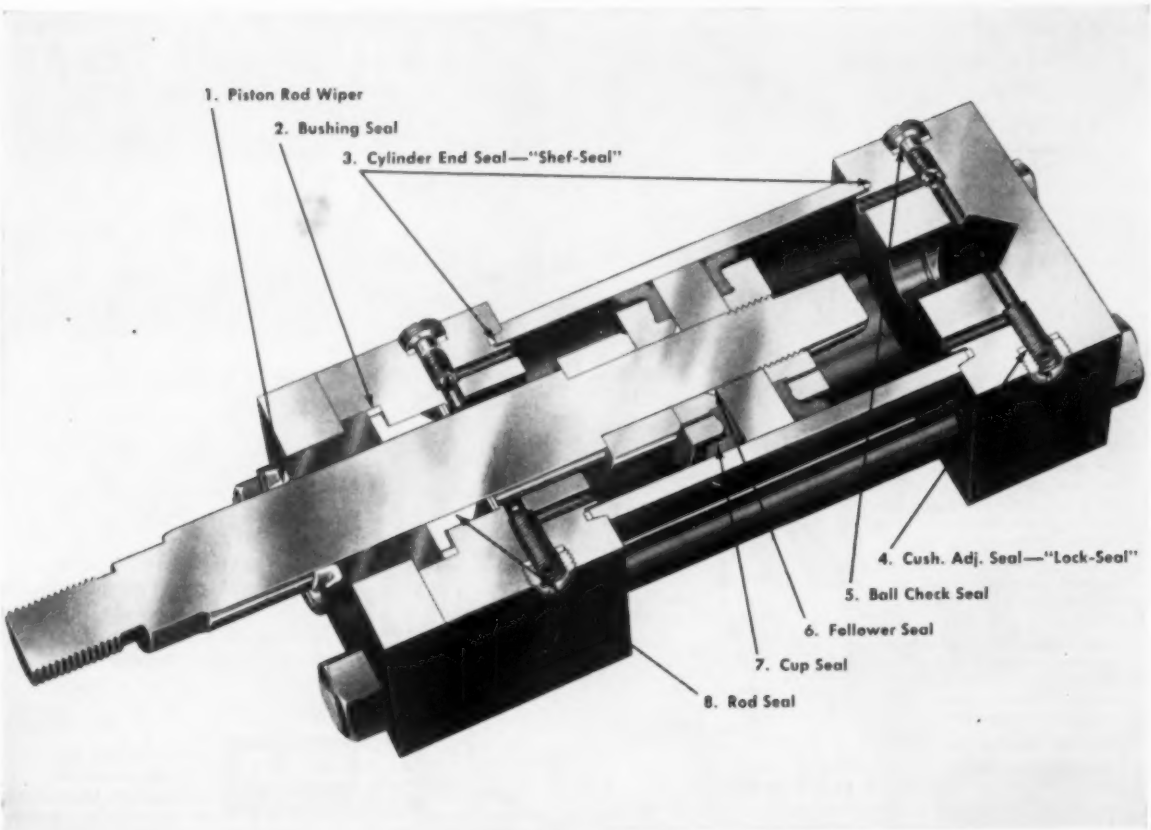
Attention Representatives

MAGNALOY

FLEXIBLE DRIVE COUPLINGS

PATENTS PENDING

CIRCLE 38 ON TIME-SAVER CARD



Assures completely safe operation in hazardous conditions of service: new all-Teflon externally sealed construction of Miller Hydraulic Cylinders accommodates Monsanto's fire-resistant Pydraul F-9 hydraulic fluid "—for applications where no leakage can be tolerated."

Cutaway view of Miller Hydraulic Cylinder illustrates "zero leakage" sealing of models in the Power-Packed Line (Model H) for 3,000-5,000 psi. service and in the Job-Rated Line (Model J) for 500-2,500 psi. service.

Hydraulic cylinder by Miller Fluid Power Div., Flick-Reedy Corporation, Melrose Park, Ill.

Safe near molten metal, open flame, high heat and other "danger zones"— Miller Hydraulic Cylinders with fire-resistant Pydraul

No matter how hazardous the situation, Pydraul F-9 operates your hydraulic equipment safely in virtually any application. Ordinary hydraulic fluid may burst through a broken line to start a fire 40 feet or more from the operating area. Pydraul F-9 hydraulic fluid, in tests and actual service, has been discharged over molten metal and red-hot ingots—sprayed through the flame of a welding torch and over an arcing field rheostat—spilled on hot presses and furnaces—all without igniting.

Firesafe Pydraul F-9 gives efficient, dependable performance under every pressure extreme found in industry because it lubricates like a premium-grade petroleum oil. Good anti-wear features and noncorrosive properties help keep hydraulic equipment working longer between overhauls—cut maintenance expense and reduce costly down time. High stability lets you reclaim Pydraul simply by cleaning to save money on replacement fluid.

Pydraul F-9 benefits help hydraulic equipment achieve assured safety—win more jobs—wherever flammable hydraulic fluid so much as hints at being a fire hazard. Why not see where and how Pydraul can help you? Write for the 24-page Pydraul F-9 Fact Book and your Hydraulic Fluid Hazard Survey Sheet, today.

MONSANTO CHEMICAL COMPANY
Organic Chemicals Division, Dept. OEM-15
St. Louis 24, Missouri

Pydraul F-9—first and only hydraulic fluid listed by Underwriters' Laboratories: "In respect to fire hazard, Pydraul F-9 is rated by Underwriters' Laboratories, Inc., 2 to 3 in a class much less flammable than paraffin (petroleum) oil, according to a schedule in which Ether is rated 100; Gasoline, 90-100; Alcohol (ethyl), 60-70; Kerosene, 30-40; Paraffin oil, 10-20."

Pydraul: Monsanto T. M., Reg. U. S. Pat. Off.

Monsanto

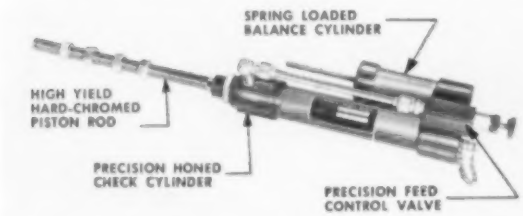
Where Creative Chemistry Works Wonders For You

CIRCLE 95 ON TIME-SAVER CARD

CIRCLE 13 ON TIME-SAVER CARD

NEW Self-Contained HYDRAULIC POWER CHECK . . .

for smooth, precise feed control of air cylinders and machines


SPRING LOADED BALANCE CYLINDER
HIGH YIELD HARD-CHROMED PISTON ROD
PRECISION HONED CHECK CYLINDER
PRECISION FEED CONTROL VALVE

■ Designed for smooth, precise control of air cylinder piston rod motion, the new APPCO Hydraulic Power Check prevents chatter and provides uniform feed unaffected by variations in power thrust.

It can be adjusted to permit any sequence of rapid travel, stop and variable feed in either or both directions.

Easily adjusted, the power check provides an opposed force to control the feed elements on grinding machines, assembly fixtures, lathes and other production equipment.

Write for detailed literature.

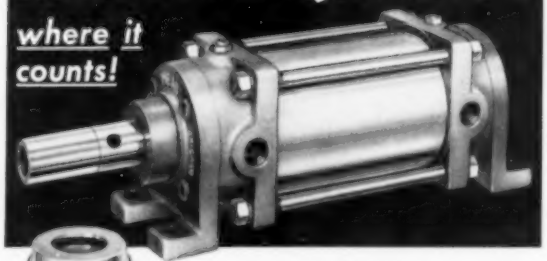
FEATURES

- Exclusive — metering valve can remotely control unit.
- Load capacities — 1500, 3000 or 6000 lbs.
- Meet or exceed AN and JIC specs.
- Strokes
  Model 1500 — 2" to 8"
  Model 3000 — 2" to 20"
  Model 6000 — 4" to 18"

APPCO Corporation
P.O. BOX 6 • OLMSTED FALLS, OHIO

CIRCLE 89 ON TIME-SAVER CARD

MASSIVE QUALITY *where it counts!*



MEEHANITE BEARING CARTRIDGE

'58

New Cylinders . . .

New line of Mead air cylinders, 16 sizes, mounts. Larger-than-ever ram bearing holds strict alignment, eases friction. Quick-detachable bearing cartridge to replace ram seals in minutes. Adjustable, convertible cushions, non-cushions or semi-cushions at either or both ends. Universal cylinders with interchangeable mounts (250 PSI). *Millions* of cycles prove they will take it. Get complete data from

MEAD SPECIALTIES COMPANY
4114 N. Knox Ave.
Dept. AH-98
Chicago 41, Illinois

IT COSTS LESS TO USE THE BEST!

PLS

1. High lead content provides positive damming action to assure a perfect seal in the handling of all petroleum base and non-flammable fluids, except those with ester base.
2. Handles high pressures up to 6000 psi.
3. Never washes out—one application lasts forever.
4. Never hardens: joints may be easily broken after years of service—no damaged connections. •

For your convenience: available in handy 1-lb. brush top cans.

Prove it to yourself. Send for a free sample. Crane Packing Co., 6405 Oakton St., Morton Grove, Ill. (Chicago Suburb).
In Canada: Crane Packing Co., Ltd., N. Hamilton, Ont.

CRANE PACKING COMPANY

CIRCLE 33 ON TIME-SAVER CARD

AIR & STEAM COUPLERS

WITH SLEEVE RINGS

Designed for rugged use on automotive and industrial air or fluid lines and steam installations up to 180 lbs. pressure or 380° F.

- Heavy duty construction with check valves in coupler bodies.
- Sleeve rings materially aid in connecting and disconnecting.
- Operator can easily couple or uncouple line even with heavy gloves or oily hands.
- Available in the "R" series for air or the "S" series for steam.
- "S" series ideal for steam molds, vulcanizers, steam cleaners, sterilizers, etc.
- Both "R" and "S" series available in 3 basic body sizes with pipe threads from ⅛" to ¾".

WRITE FOR INDUSTRIAL CATALOG No. 4

TRU-FLATE® INC.

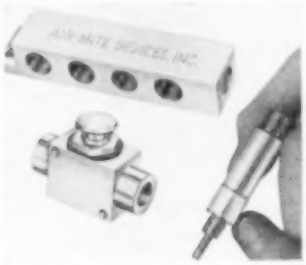
888 — 92nd AVENUE • OAKLAND 3, CALIFORNIA

CIRCLE 133 ON TIME-SAVER CARD

NEW PRODUCTS

MINIATURE COMPONENTS
. . . are rugged and compact

Construction: All components (cylinders, valves, and fittings) have standard 1/8 in. pipe threads. The 3/8 in. bore, 1/2 in. stroke, spring return cylinder is machined



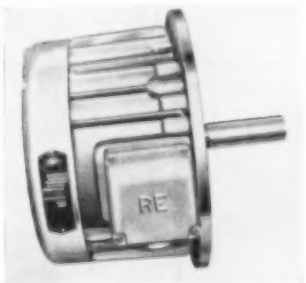
from aluminum bar stock. Piston, ram, and end cap are cold rolled steel. Packing can be replaced easily. The 3-way normally-closed valve can be serviced without removing it from the line. Many cylinders can be operated from a single pressure source with the 8-port manifold. Company makes all parts needed to assemble a complete miniature power package.

Air-Mite Devices Inc.
Chicago, Ill.

CIRCLE 322 ON TIME-SAVER CARD

ELECTRIC MOTORS
. . . have high heat dissipation

Features: Fin type design and cast aluminum housing remove heat three times as efficiently as cast



iron. Vibrationless running and wafer thin compactness. Rotors dynamically balanced mounted on heavy-duty ball bearings. Thin, low inertia rotor for smooth starts and quick stops.

Specifications: Rating 1/2 to 10 hp in totally enclosed fan cooled

Continued on next page

Your Tight Specifications Require the Tightest Seal!

MARSH IMPREGNATED THERMO-LEATHER PACKINGS

58 years of packing experience and extensive research *plus* development of the finest synthetic impregnations gives assurance of satisfaction in your specific packing requirements.

- Low coefficient of friction
- Greater wear resistance
- Tighter sealing
- Temperature stability

LEATHER . . . For the Best Seal

Field experience is constantly proving the leather packing impregnated to fluid conditions is superior to other materials—the one seal which will conform in operation to its housing—creating immediate and continual sealing with each pressure application!!

Engineering and Consulting Service
If you seal oil, water, air, vacuum, gas, gasoline, naptha, alcohol or other fluids, ask MARSH for field engineering service, immediately available to you for the job you are designing, tooling, manufacturing.

MARSH BEST SINCE 1900 LEATHER PACKINGS

C. W. MARSH COMPANY

MAIN OFFICE AND FACTORY • MUSKEGON, MICHIGAN

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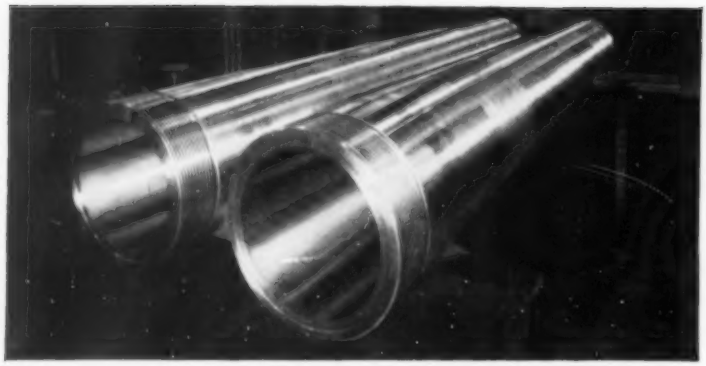
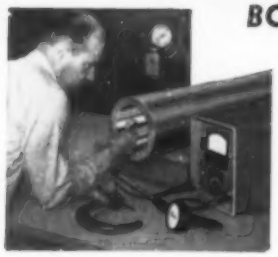
CIRCLE 85 ON TIME-SAVER CARD

CIRCLE 9 ON TIME-SAVER CARD





BORED and HONED to MIRROR FINISH

American, specialists in boring and honing of hydraulic or air power cylinders, is your dependable source. We work in any material to your specifications. Write or phone us for estimates.

TELEPHONE ERIE 2-3664

PRECISION INTERNAL MACHINING AHB

MANUFACTURERS OF HYDRAULIC CYLINDERS • SPINDLES • SLEEVES CLUTCH SHAFTS • PISTON RODS • RAMS • QUILLS, ETC.

AMERICAN HOLLOW BORING CO.

1954 Raspberry St., Erie, Pa.

NEW PRODUCTS

and totally enclosed non-ventilated for continuous or intermittent duty.

Reuland Electric Co.
Alhambra, Calif.

CIRCLE 323 ON TIME-SAVER CARD

AIR CYLINDERS . . . have self-locking cushion adjustment

Features: Ball check and cushion adjusting screw don't protrude beyond mounting surface of cylinder,

and they are interchangeable. Self-locking screw does not require a lock nut. Both ball check and cushion adjusting screw are sealed against leakage with Teflon and withstand temperatures to 450 F.

Miller Fluid Power Div.
Flick-Reedy Corp.
Melrose Park, Ill.

CIRCLE 324 ON TIME-SAVER CARD

Continued on page 140

New, improved subplate and sandwich

CHECK VALVES

for hydraulic systems up to 5000 psi

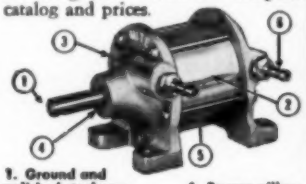
Rugged, new line of improved Check Valves to block oil flow in one direction, but allow reverse free flow. Built for hydraulic systems up to 5000 psi in two sizes—¾" and 1¼"—in either subplate-mounted or sandwich types. Valve operation based on spring-loaded poppet allows flow through valve at cracking pressure of 10 psi. Reverse flow is blocked. Spring-loading feature allows mounting in any required position. Subplate type meets JIC standards—available with or without matching subplate. Sandwich type allows adding check valve to circuit without adding or breaking pipe connections. Write for full details in Bulletin VC-1-B. Denison Engineering Division, American Brake Shoe Co., 1166 Dublin Road, Columbus 16, Ohio.

CIRCLE 36 ON TIME-SAVER CARD

AIR-MITE AIR CYLINDERS

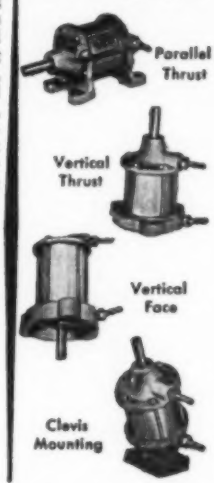
Low Cost . . Compact . . Powerful . . Rugged

AIR-MITE Cylinders—made in single or double acting series—in 4 mounting types, are high quality cylinders at a low price. Simple, rugged design and compact construction give them long life, permit easy mounting on jigs, fixtures, tools, or machines. Used wherever power holding, pushing, pulling or lifting is required, AIR-MITE cylinders will meet your most exacting standards of dependability and long life. Write for complete catalog and prices.



1. Ground and polished steel ram
2. Brass, true-bore cylinders
3. High strength aluminum alloy cylinder heads
4. Bronze oilless ram bushing
5. Five steel tie rods
6. Brass hose stems

4 Mounting Types



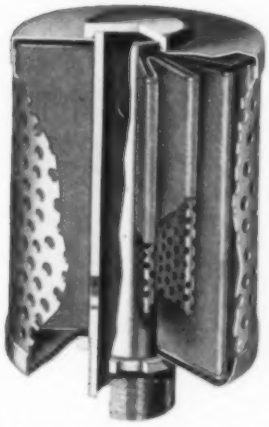
AIR-MITE Devices, Inc.

4401 W. KINZIE • CHICAGO, ILLINOIS

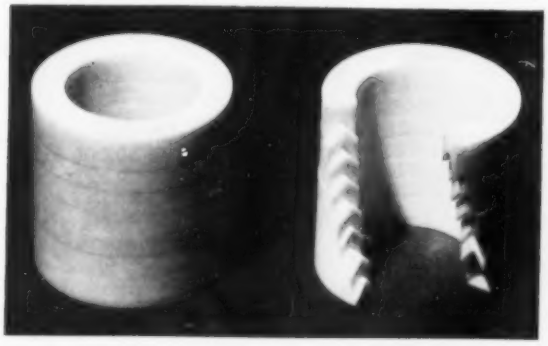
CIRCLE 6 ON TIME-SAVER CARD

NEW SUMP OIL FILTER

for hydraulic and lube oil systems



● Screen wire mesh reinforced by pleated perforated metal provides greatly extended filtering area. This results in lower pressure drop, larger dirt capacity. Entire unit protected by perforated cover to prevent accidental damage. A wide choice of bronze, monel, or stainless media provides various degrees of positive filtration. Capacities from 1 to 100 gpm, male or female connection. Write for Specification Sheet OCO-1057. **AIR-MAZE CORPORATION**, Cleveland 28, Ohio. Dept. AH-9.



DORE "V" RINGS OF TEFLON* ARE SUPERIOR

Because—

1. Uniform density, even out to the feather edge of the lip, insures proper, continuous pack-off, longer and better flex-life.
2. Rings are manufactured to close tolerances providing a tight seal with low gland pressure.
3. A special satin finish is added to give Doré "V" rings of Teflon an extremely low coefficient of friction.

In addition to V-Rings, Doré is molding Cup and Cone Packings, "U" Cup Packing, Piston Cups and Flange Packing of Teflon.

For Superior molded Teflon products, write for Doré Catalog.

* DuPont's registered trademark

John L. Doré Co.

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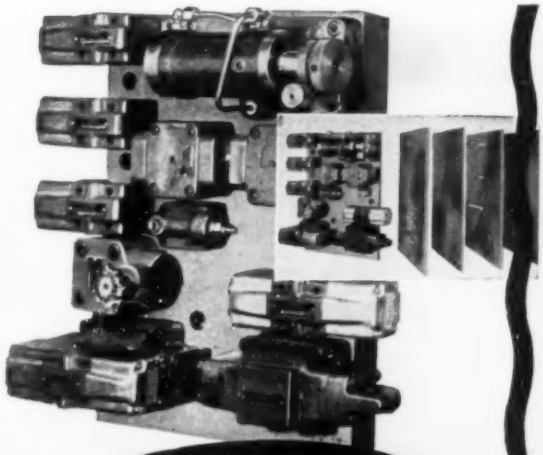
Export: 1505 Race St. • Philadelphia 2, Pa., U.S.A.
Cable Address: DORIEX

SALES-ENGINEERS FOR JOHN L. DORE, INC.

DU PONT'S TEFLON HI-QUALITY NYLON

CIRCLE 39 ON TIME-SAVER CARD



ALMO

HYDRAULIC CONTROL MANIFOLDS

CONTROL SYSTEMS READY FOR OPERATION—NO CIRCUITS TO PONDER OVER AT INSTALLATION

Leading machine manufacturers use these manifolds to cut costs and obtain permanent trouble-free operation. Send your hydraulic circuit print and sketch showing desired take-off connections. We'll prepare a manifold proposal—No obligation.

ALMO TOOL COMPANY
11470 Kaltz—Centerline, Mich.

"Design Wise"

Colonial Broach Co. uses an Almo manifold in this 15 ton capacity, 66" stroke dual-ram broaching machine.

CIRCLE 8 ON TIME-SAVER CARD

NEW PRODUCTS

SERVO VALVE
. . . for resonant load damping

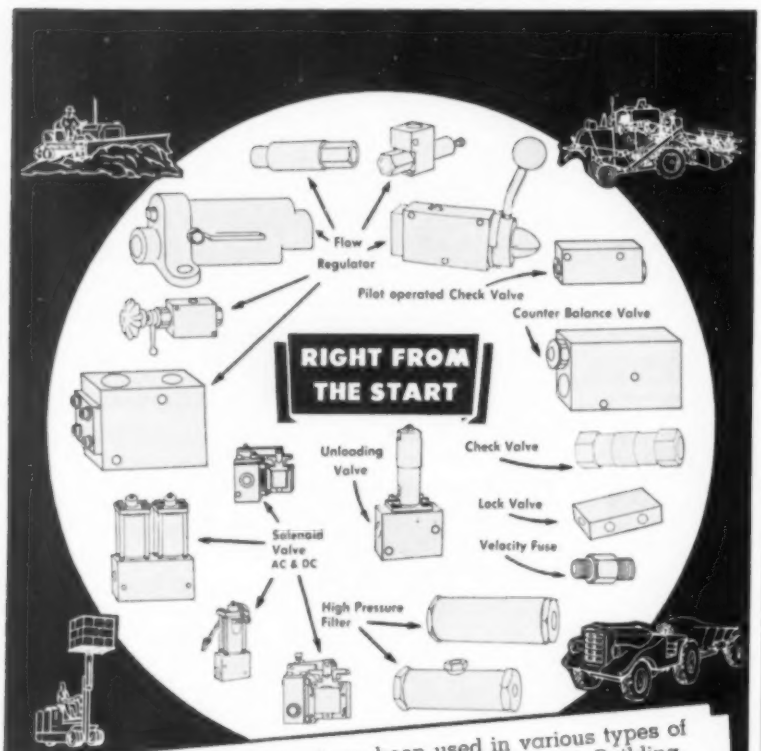
Designation: Series 16

Features: Feeds back cylinder pressure differential internally. Gives controlled dynamic pressure-flow characteristics for effective damping. Sensitivity of flow to load pressure can be altered to provide the best damping for a particular

load. At low frequencies it works as a flow control valve to give high system stiffness. Gain and effective time constant of pressure feedback can be varied to meet requirements.

Moog Valve Co., Inc.
East Aurora, N. Y.

CIRCLE 325 ON TIME-SAVER CARD



All of the above valves have been used in various types of applications including Material Handling, Road Building, Machine Tool, Farm Equipment and Earthmoving.

Waterman Engineering Company has also supplied valves to the military for Ground Support Equipment and Missile Launchers. We invite you to send us your applications and take advantage of our experience to help analyze your problems.

Bulletins of any of these products sent on request.

WATERMAN
ENGINEERING COMPANY
725 CUSTER AVENUE · EVANSTON, ILLINOIS

CIRCLE 147 ON TIME-SAVER CARD

MINIATURE CYLINDERS
. . . work toy dump truck

Design: Made in ⅜ to ¾-inch bores and strokes from ½ to 6-inch. They are made of aluminum and can be anodized in many different colors. They are single-acting and can be furnished with spring return.

Application: Presently the cylinders are being used by toy manufacturers for realism and action in

toy hydraulic dump truck bodies. A hi-fi set manufacturer is also using the units for counter-balance.

Mo-Bar Hydraulic Sales Inc.
Crystal Lake, Ill.

CIRCLE 326 ON TIME-SAVER CARD

AIR-OPERATED VALVES
. . . for pressures to 60,000 psi

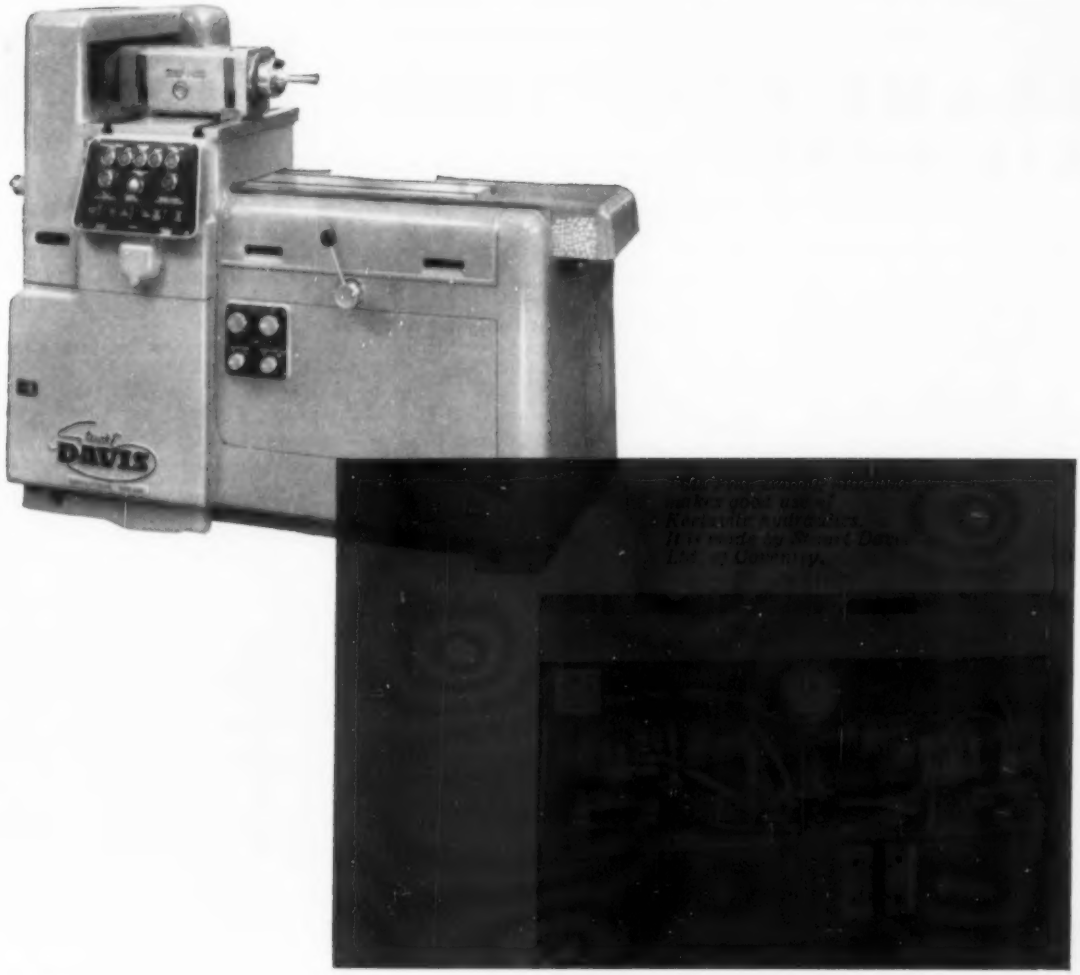
Designation: Remarco

Design: Valves are for on-off service and are designed to operate on 6 to 30 psi instrument air. They can be operated three ways; air to open, spring to close, spring to

open, air to close, or air to open and close. A self contained mounting bracket is integral with the valve body.

Specifications: Valve bodies are made in 316 and 410 stainless steel.

Continued on page 142



HYDRAULICS FOR MACHINE TOOLS

We at Keelavite are a team of experts in the design, installation and maintenance of complete hydraulic systems. We are ready to accept full responsibility for the proper working of all our installations, including all electrical or other control equipment.

Not only this, we are the manufacturers of the largest range of hydraulic units in the United Kingdom.

We are, of course, fully experienced in special applications of hydraulic power for the machine tool industry.

KEELAVITE
Hydraulics

MACHINE TOOL DIVISION

THE RECOGNISED AUTHORITY

KEELAVITE ROTARY PUMPS & MOTORS LTD
ALLESLEY, COVENTRY Telephone: Meriden 441

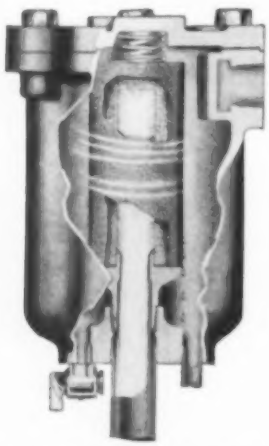
583

CIRCLE 75 ON TIME-SAVER CARD

CIRCLE 2 ON TIME-SAVER CARD

ADAMS PORO-STONE AIR FILTER

designed to remove oil, water and foreign matter from compressed air lines with minimum pressure drop.

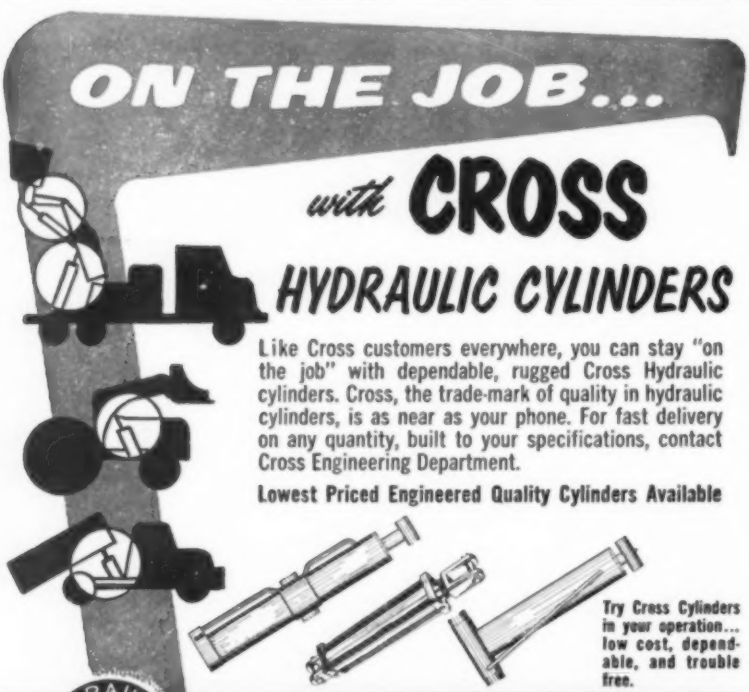


The R. P. Adams Poro-Stone air filter is engineered to efficiently remove entrained oil, water and pipe scale from compressed air lines. Liquid droplets and solids being carried by the gas stream are first removed by centrifugal action in an annular chamber. Secondary filtration is achieved by passing the air or gas stream through a Poro-stone unit. An automatic trap can be provided to discharge the residue from the cyclone chamber.

At rated capacity the filters operate at a maximum pressure drop of only ½ lb., thus insuring delivery of line pressure to the point of consumption.

The units require virtually no service or maintenance — thereby insuring continued trouble-free, low cost performance.

ADAMS Poro-Stone air filters are available from stock in sizes to suit your needs. For further information, write today for Bulletin 117, R. P. Adams Co., Inc., 249 East Park Drive, Buffalo 17, New York.


ON THE JOB...
with CROSS
HYDRAULIC CYLINDERS
Like Cross customers everywhere, you can stay "on the job" with dependable, rugged Cross Hydraulic cylinders. Cross, the trade-mark of quality in hydraulic cylinders, is as near as your phone. For fast delivery on any quantity, built to your specifications, contact Cross Engineering Department.
Lowest Priced Engineered Quality Cylinders Available
Try Cross Cylinders in your operation... low cost, dependable, and trouble free.
HYDRAULIC CYLINDERS
CROSS
CROSS MANUFACTURING CO.
LEWIS, KANSAS—EA 45525
WRITE • WIRE • PHONE

CIRCLE 32 ON TIME-SAVER CARD

NEW PRODUCTS

Seats and stems are replaceable. They are also made with an adjustable limit switch for remote indication of valve position. Sizes range from ⅛ to 9/16 in.

High Pressure Equipment Co., Inc.
Erie, Pa.

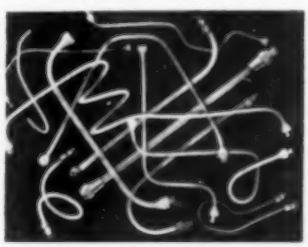
CIRCLE 327 ON TIME-SAVER CARD

POLYAMIDE HOSE ASSEMBLIES

. . . are prefabricated

Designation: Nylaflow

Features: Gives uniformity of assemblies and reduces cost. Lightweight for shipping and handling. Long storage life. Are form stable



but flexible enough to be positioned for assembly.

Specifications: Made in ⅛ to ⅜ in. tubing. Burst pressure ratings to 2500 psi. Nylon or metallic fittings. Can be permanently bent by heat.

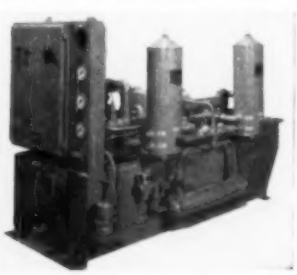
Polymer Corp. of Penna.
Reading, Pa.

CIRCLE 328 ON TIME-SAVER CARD

OIL SUPPLY SYSTEM

. . . for gun drilling

Features: Four section settling tank, each with access cover and



drain. Disposable 5 micron filters rated in excess of gpm required. Standard equipment includes; heat exchangers, water control valves,

Continued on page 144

For Dependable Fluid Power...

Superior Single Shell Accumulators

■ Because of its simple design and safe, rugged construction, the SUPERIOR Single-Shell Accumulator provides the high degree of reliability demanded on critical missile and ground support equipment.

Superior accumulators operate in any position, prevent gas loss, eliminate the possibility of system contamination.

Currently in use on the NIKE, THOR, BOMARC and other well-known missile projects, SUPERIOR accumulators are available in sizes up to and including 2,300 cu. in. of net gas volume. Models with greater capacities available on request.

* Certified by an independent testing laboratory to meet MIL-A-5498C (ASG) specifications.

Pressure curve available on request.

Write for details.

Superior Hydraulics Division

15201 St. Clair Ave. • Cleveland 10, Ohio • POtomac 1-9313

Division Of Superior Pipe Specialties Co. • 2917 S. Cicero Ave. • Cicero 50, Ill. • OLympic 2-9132

CIRCLE 129 ON TIME-SAVER CARD

37° FLARED "J.I.C." and FLARELESS

NEW PRODUCTS

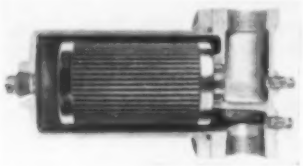
low level alarm, variable displacement high pressure pump, electrical control panel, gage panel and solenoid shut-off valve. Pressures to 1000 psi and capacities to 37.5 gpm.

The Cardwell Machine Co.
Richmond, Va.

CIRCLE 329 ON TIME-SAVER CARD

LINE FILTER
. . . for temperatures to 300 F

Features: For oil and fire-resistant fluids. Can be made with by-pass



valve. Openings for vacuum or pressure gauge. Element is easily removed for cleaning. Corrugated filter screen gives large filtering area.

Specifications: Made in standard pipe sizes for pressures to 150 psi. Capacities, 10, 20, 30, 50, and 75 gpm. Monel wire cloth 30 to 100 mesh.

Marvel Engineering Co.
Chicago, Ill.

CIRCLE 330 ON TIME-SAVER CARD

HOSE FITTINGS
. . . in handy utility kit

Features: Contains 42 most widely used couplings and swivel adapters. For use in the field or shop. Fittings have double-wedge grip. They bite through the rubber cover and grip

solidly to the wire braid. No mandrel or special tools required to assemble. Swivel adapters in the kit have many thread combinations for standard and special threads.

Alemite Division
Stewart-Warner Corp.
Chicago, Ill.

CIRCLE 331 ON TIME-SAVER CARD

TUBE CONNECTOR
. . . has quick release

Features: Easy to connect. Push over end of tubing to stop position. This locks tubing in place and gives a leak-proof seal. To remove, press thumb pad and pull

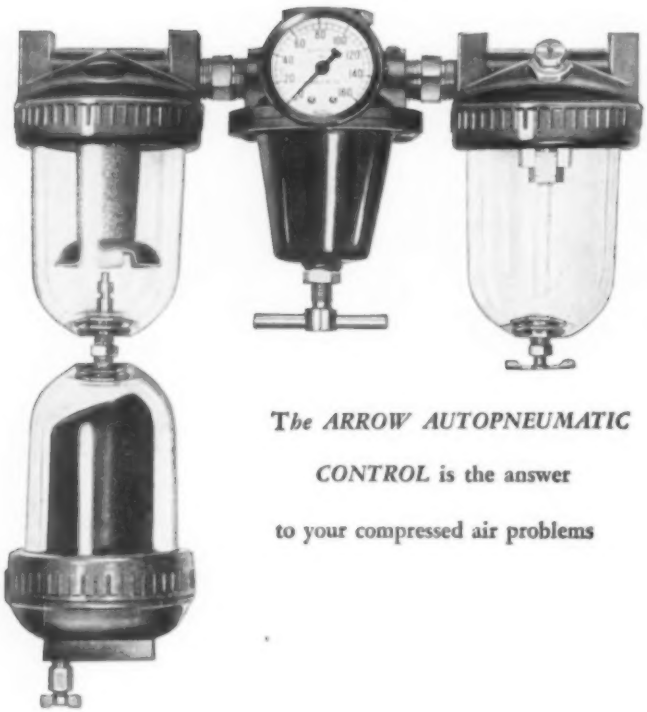
off connector. Can be used as a tube plug by threading a pipe plug into end of connector.

Specifications: Made for ¼ to 1½ inch tubing. Temperature range —40 to 275 F. For air, water, or oil.

Mechanical Products Corp.
Chicago, Ill.

CIRCLE 332 ON TIME-SAVER CARD

Continued on page 146



The ARROW AUTOPNEUMATIC CONTROL is the answer to your compressed air problems

Write for Free Catalog

ARROW TOOLS, INC.
1934 S. Kostner Ave.
Chicago 23, Illinois

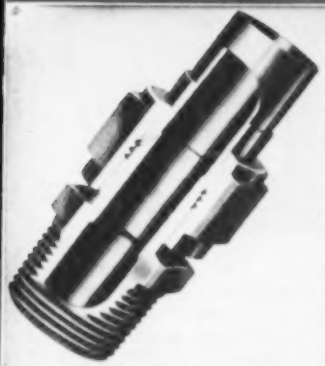
CIRCLE 14 ON TIME-SAVER CARD

AFCO

37° FLARED "J.I.C." and FLARELESS
TUBE • PIPE and HOSE

FITTINGS

STEEL • ALUMINUM ALLOY • BRASS • STAINLESS STEEL



37° FLARED "J.I.C."

FLARED TUBE FITTINGS and PIPE FITTINGS

J 815 TUBE UNION	J 815-X-X REDUCER UNION						
J 816 MALE CONNECTOR	J 854 FEMALE CONNECTOR	J 821 TUBE ELBOW	J 822 MALE ELBOW	J 877 LONG MALE ELBOW	J 878 EXTRA LONG MALE ELBOW		
J 823 MALE ELBOW 45	J 855 FEMALE ELBOW	J 824 TUBE TEE	J 825 MALE SIDE TEE	J 826 MALE RUN TEE	J 856 FEMALE SIDE TEE		
J 857 FEMALE RUN TEE	J 827 TUBE CROSS	J 832 BULKHEAD UNION	J 833 BULKHEAD ELBOW	J 834 BULKHEAD TEE	J 837 45° BULKHEAD ELBOW	J 806 TUBE PLUG—FLARED	J 860 TUBE END REDUCER
J 818 TUBE NUT	J 819 TUBE SLEEVE	J 820 TUBE CAP—FLARED	J 924 BULKHEAD LOCKNUT	910 PIPE CONNECTOR	911 PIPE NIPPLE	912 REDUCING BUSHING	913 SQUARE HEAD PLUG
914 90° STREET ELBOW	915 45° STREET ELBOW	916 PIPE ELBOW	917 PIPE TEE	918 PIPE CROSS	932 HOLLOW HEX PLUG	933 HEX HEAD PLUG	840 HOSE NIPPLE

FLARELESS TUBE FITTINGS

				F 815 TUBE UNION	F 815-X-X TUBE UNION REDUCER	842 90° HOSE ELBOW	844 45° HOSE ELBOW
F 816 MALE CONNECTOR	F 854 FEMALE CONNECTOR	F 821 TUBE UNION ELBOW	F 822 90° MALE ELBOW	F 823 45° MALE ELBOW	F 855 FEMALE ELBOW	F 824 TUBE TEE	F 825 MALE SIDE TEE
F 826 MALE RUN TEE	F 856 FEMALE SIDE TEE	F 857 FEMALE RUN TEE	F 827 TUBE CROSS	F 832 BULKHEAD UNION	F 833 90° BULKHEAD ELBOW		
F 834 BULKHEAD TEE	F 837 45° BULKHEAD ELBOW	F 860 TUBE END REDUCER	F 818 TUBE NUT	F 819 TUBE SLEEVE	F 924 BULKHEAD LOCKNUT		
F 929 TUBE CAP	F 806 TUBE PLUG						

FLARELESS

AFCO FITTING CO.

5300 Harvard Avenue Cleveland 5, Ohio

SEND FOR CATALOG ON THE COMPLETE LINE OF— **AFCO INDUSTRIAL FITTINGS**

CIRCLE 1 ON TIME-SAVER CARD

Fall . . . the original

SPRING-LOADED

Wiper **Ring**

This patented closed joint ring provides squeeze-grip action, assuring complete contact on the rod at all times. Maintains uniform, continuous pressure on wiper edge. Rods are always clean in any temperatures.

Fall "CJ" Wiper Rings operate most effectively under extreme conditions of dust, glaze, oil, grit, powder, gases, sand, ice, etc. Available in diameters ½" through 13". For any commercial use. Used by military and aviation industry since 1944.

ACE PRODUCTS CO.

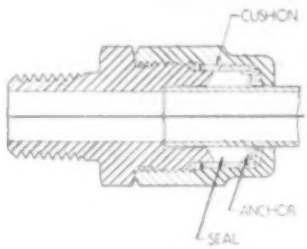
1820 N. 12th St. Toledo 1, Ohio
Est. 1935

NEW PRODUCTS

FLARELESS TUBE FITTING
. . . absorbs shock

Designation: Rubberneck.

Features: Can be connected and disconnected repeatedly. Needs no flaring, welding, or soldering of tube. Built in stop prevents over



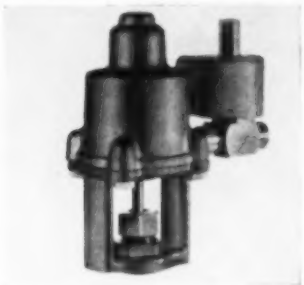
torquing. Furnished as a complete assembly for easy installation. Seals misaligned tubes. Holds pressure above burst pressure of tubing.

Chicago Forging & Mfg. Co.
Chicago, Ill.

CIRCLE 333 ON TIME-SAVER CARD

CYLINDERS
. . . have built-in solenoid valve

Design: Single acting with integral 3-way solenoid valve. For valve actuators or heavy duty levers or latches.



Specifications: The 3½ in. size has a cast iron frame and top plate, cadmium plated steel cylinder, stainless steel stem and return spring, and Buna N piston and packing. Maximum load at 50 psi, 360 lbs. The 2¼ in. size has a bronze frame and cylinder and a maximum of 375 lbs at 150 psi. Can be used with air, water, or oil.

Automatic Switch Co.
Florham Park, N. J.

CIRCLE 334 ON TIME-SAVER CARD

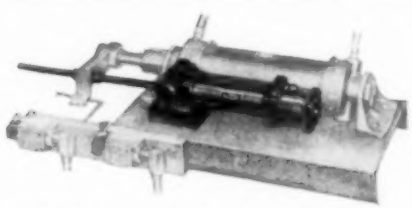
Continued on page 149

Write . . . for this valuable NEW Catalog Bulletin

SPAN BRASS MFG. CO. INC.
OTSEGO, MICHIGAN

CIRCLE 125 ON TIME-SAVER CARD

VERI-TROL (TRADEMARK) HYDRAULIC
CHECKING CYLINDERS



—designed for use with air cylinders to smooth out stroke variations due to compressibility of air under irregular load conditions.

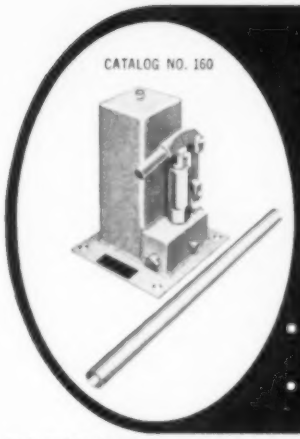
- **ACCURATE SPEED CONTROL is dial-set, load-compensated to assure uniform stroke speed even with irregular loads.**
- **VISIBLE OIL RESERVOIR, easy to refill.**
- **2,000 LB. CHECKING CAPACITY on out stroke, free return.**
- **2", 4", 6", 9", 12", 15" and 18" checking stroke lengths.**
- **IDEAL FOR LOW-COST TOOL OR WORK-PIECE FEEDS.**

Take the bumps and jumps out of air cylinder operation — install VERI-TROL checking cylinders wherever you want smooth, accurately-controlled stroke speed. Write now for free data bulletin.

Modernair (TRADEMARK) CORPORATION
Dept. B-9, 400 PREDA STREET, SAN LEANDRO, CALIF.
Member National Fluid Power Association 34

CIRCLE 94 ON TIME-SAVER CARD

CIRCLE 106 ON TIME-SAVER CARD



Hand Hydraulic Pumps

- Single and Double Designs to 20,000 psi
- With or Without Reservoir

160 cubic inch reservoir with 8"x 8" base plate and 18" long handle.

Available with optional size pistons ⅜", ½", ¾", 1" and 1½".

We specialize in the manufacture of hand pump units which operate in temperatures from −65° F. to +160° F. and with any capacity reservoirs required. Pumps can be furnished on special order with custom seals to handle various aircraft types of fuels such as Pydraul, Skydrol, Oronite, etc.

The single pump with ½", ¾", 1" or 1½" piston is now available in stainless steel.

for additional information write:

WILLIAM S. PINE

hydraulic hand pumps for 1001 uses

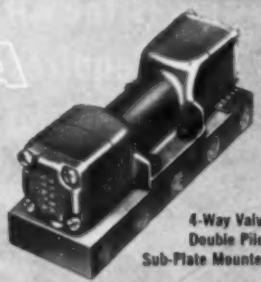
1635 East 22nd St., Los Angeles 11, Calif.

CIRCLE 139 ON TIME-SAVER CARD

FOR SUB-PLATE MOUNTING

VERSA

Manifold Mount VALVES



4-Way Valve
Double Pilot
Sub-Plate Mounted

For any type of operation... there's a Versa Control Valve available for manifold mounting. These efficient, compact Control Valves are ideal for incorporation as original equipment. They can be installed directly on equipment or mounted on standard Manifold Plates (or Sub-Plates).

Versa Manifold Mount Valves are available with any type of actuating device, in sizes from 1/8" to 1" NPT, in 2-, 3-, 4-, and 5-Way Types, and for pressures from partial vacuum to 500 PSIG.

Over 110,000 Variations...
Available for Immediate Delivery!

VERSA

VERSA PRODUCTS COMPANY INC.
248A SCHOLES STREET, BROOKLYN 6, N.Y.

SELF-CLOSING VALVES by LISLE

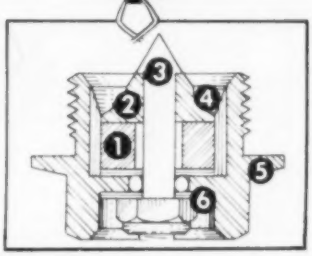
In any assembly using synthetic lubricant — particularly for aircraft applications — **Lisle Self-Closing Valves** are advantageous in conjunction with either Lisle Magnetic Plugs or Chip Detectors.

They eliminate oil loss during inspection and reduce fire hazards due to draining into cowling and airframe.

Illustrated above is the vertical-seal design with a Lisle Magnetic Chip Detector fully removed (top photo) and halfway installed (bottom).

Lisle Self-Closing Valves make it more convenient to service Magnetic Chip Detectors and Magnetic Plugs.

CHIP DETECTORS by LISLE



One of the many Lisle Magnetic Chip Detector Designs, showing (1) Alnico Magnet (2) Magnet Extension (3) Non-Magnetic Terminal Shaft (4) Insulating Tube (5) Plug Body (6) O Ring.

LISLE CORPORATION

Clarinda, Iowa

Write for Data and Low-Cost Test Samples of self-closing Valves or Chip Detectors.

CIRCLE 83 ON TIME-SAVER CARD

for extreme temperatures

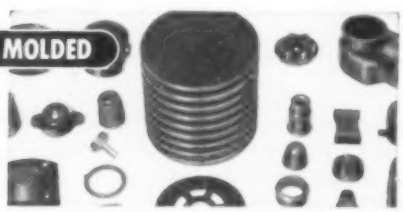
SILICONE

RUBBER PARTS AND COMPONENTS BY

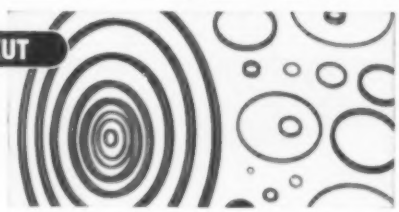
Goshen Rubber

Goshen-developed silicone rubber compounds offer properties like resistance to temperature extremes —80 to +500° F; resiliency over a range of —120° F to +600° F; low compression set; resistance to chemicals, oxidation, ozone, moisture, corrosion, shock, abrasion; freedom from stain, odor, tackiness and toxicity; same shrinkage as organic rubber, with resultant advantages.

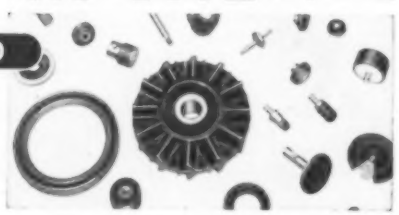
CUSTOM MOLDED



LATHE CUT



BONDED



GORSIL compounds are now available for adaptation to your next part problem that involves temperature.

QUALITY ENGINEERED RUBBER PRODUCTS

Goshen Rubber Co., INC.

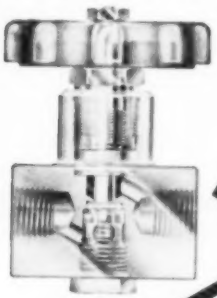
1398 S. TENTH ST. GOSHEN, INDIANA

CIRCLE 56 ON TIME-SAVER CARD

CIRCLE 27 ON TIME-SAVER CARD

NEW MODEL 949T MANUAL SHUT-OFF VALVE

...for superior valve leakage control by Circle Seal



CIRCLE SEAL

...easier operation with threads out of fluid stream, reduced operating torque...increased handle finger or detent depth and flow passages...for high or low pressure gas service...rated at 0-5000 psi

COMPLETE ENGINEERING DATA AVAILABLE

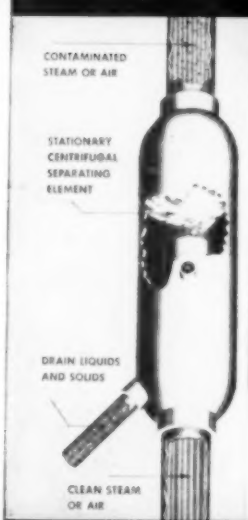
CIRCLE SEAL PRODUCTS COMPANY INC.

2181 East Foothill Boulevard, Pasadena, California

REPRESENTATIVES IN ALL PRINCIPAL CITIES

See Our Catalog in Sweet's Product Design File

This is the Air Cleaner That Requires NO MAINTENANCE



- Removes oil and moisture from air lines without filters or screens
- Revolutionary design eliminates all moving parts
- Nothing to maintain
- Low-cost—Lists from $16.50 up
- Virtually 100% efficiency in removing pipeline entrainment
- No loss of pressure
- Reduces maintenance of pneumatic equipment
- Prolongs life of air tools

ANDERSON Hi-eF PURIFIERS

FREE Send for complete catalog on these astounding air cleaners. Mail reader service card for your complimentary copy of Bulletin 502.

THE V. D. ANDERSON COMPANY

1936 West 96th Street, Cleveland 2, Ohio

CIRCLE 12 ON TIME-SAVER CARD

NEW PRODUCTS

PLUG VALVE
. . . for 3000 psi

Designation: PY 300

Design: Interchangeable stainless steel blunt stem plug or a flat Teflon disc stem plug. Made in angle pattern with bursting disc or adjustable relief valve.

Specifications: Platinum clad bursting disc is made in four psi

ranges: 1400-1600, 1800-2000, 2600-3000 and 3600-4000. Relief valve spring ranges are: 150-175, 205-300, 350-400, and 450-600 psi. Can be supplied with O-ring stem seal or Teflon packing.

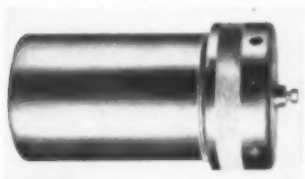
Hoke Inc.
Englewood, N. J.

CIRCLE 335 ON TIME-SAVER CARD

OIL FILTERS
. . . have fiber disc elements

Designation: 1555CP

Specifications: Capacities from 1.5 gpm at 3 psi pressure drop to 47.6 gpm at 6 psi pressure drop with



100 SSU mineral oil. Working pressure 3000 psi. Comply with ASME code for unfired pressure vessels. Can be code stamped. Inlet, outlet, and drain are in the bottom. Can be connected in parallel for more capacity.

Wm. W. Nugent & Co. Inc.
Skokie, Ill.

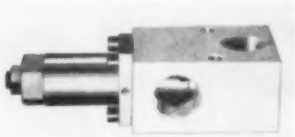
CIRCLE 336 ON TIME-SAVER CARD

RELIEF VALVES
. . . for 5000 psi

Features: Good pressure-flow characteristics. Wide selection of pressure ranges. For use where failure to hold pressure would endanger equipment.

Construction: Differential piston type. Pressure acts on the annular area between the O.D and reduced dia of piston. Effective force is not reduced by high-velocity, low-pressure ahead of seat. Settings are adjustable.

Specifications: Spring range 100 to 800, 250 to 1500, 1000 to 3000,



1500 to 5000 psi. Port sizes ¼, ⅜, ½, ¾, and 1 inch.

Fluid Controls Inc.
Mentor, Ohio

CIRCLE 337 ON TIME-SAVER CARD

Continued on page 151

BH EW

DOUBLE-ACTING
Hydraulic Cylinders
FOR OUTSTANDING OPERATIONAL PERFORMANCE

BHEW's Double-Acting Hydraulic Cylinders are designed around standard components. The special check valve makes certain the piston rod is locked in any position when the directional control valve is in neutral in order that the rod will not "drift". This simplifies hydraulic line circuitry by eliminating separate pilot operated check valves and resultant connections and lines.

- **BHEW furnishes cylinders with single or dual P. O. C. valves**
- With or without speed control.
- Available in most standard designs and sizes

Tell Us Your Design or Application Problems. We'll Show You How to Solve Them.

WRITE TODAY!
FREE copy of Hydraulic Cylinder Engineering Reference Data Manual. Save hours of time in specifying cylinders. 78 dimensioned basic designs for general and special purpose double-acting cylinders.

BENTON HARBOR
622 Langley Avenue

BH EW

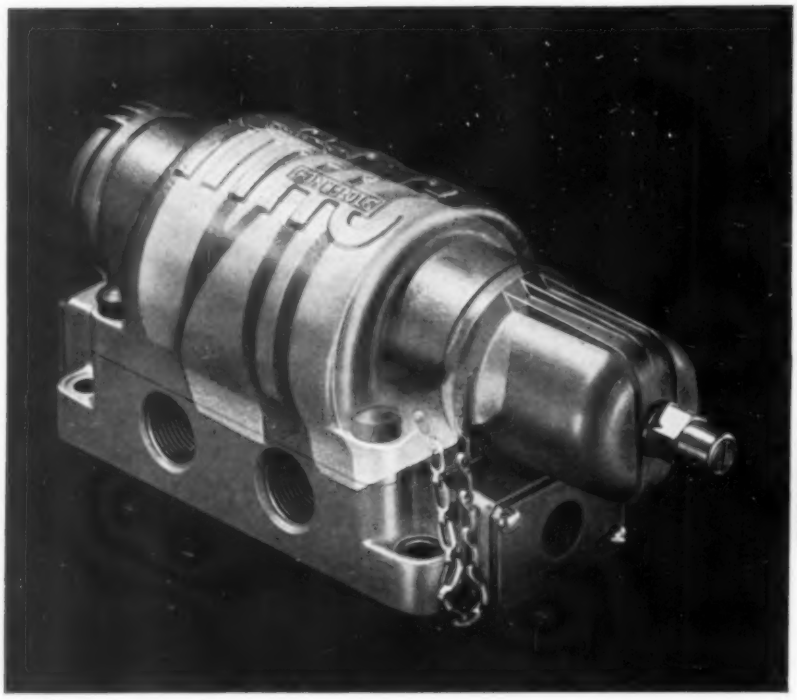
ENGINEERING WORKS, INC.
St. Joseph, Michigan

CIRCLE 19 ON TIME-SAVER CARD

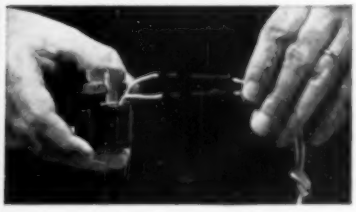
Introducing the revolutionary new MAC 4-way

DUAL-SPOOL

CIRCULAR-FLOW AIR VALVE



The MACsolenoid energizes the inner spool, releasing compressed air to activate the outer spool. There is no lag between spools. The shock load of the main spool is dissipated through rubber cushions.



The Dual-Spool's proved MACsolenoid has new instant plug-in wire lead connectors that are waterproof and vibration-proof. The solenoid and cover assembly detach in seconds without tools.

Features efficient spool-within-a-spool design... sells for about half the price of most other ½" to 1¼" valves... meets all J.I.C. specifications

MAC's new Dual-Spool air valves represent an entirely new principle in air valve design. They operate at speeds that meet any known requirement . . . with shorter stroke . . . direct operation . . . and a highly efficient *circular* air flow that provides full flow throughout rated capacities.

They operate on the *low current requirements of minimum amplified circuits* . . . needing just .8 amperes of inrush current and .125 amperes holding at 115 volts—60 cycles. The new Dual-Spool valves are compact, too . . . about one half the size of similar-use competitive valves (½" to 1¼") . . . and sell at about half the price in single- and double-solenoid models.

Fewer parts and simple design reduce maintenance. Integral conduit boxes connected by wiring channels permit optional wiring. Plug-in wire lead connectors speed up installation. The MACsolenoid—which operates up to 30 *million cycles* without appreciable wear—shaves replacement costs to a minimum.

4-way Dual-Spool air valves are now available in ½", ¾", 1" and 1¼" pipe sizes . . . are fully tested and guaranteed. Contact a MAC representative listed at the right or write direct for complete details.

Pat. applied for on all valve features ©MAC

MECHANICAL AIR CONTROLS, INC. MAC 10030 Capital, Oak Park, Detroit 37, Michigan

PHONE YOUR NEARBY "MAC" REPRESENTATIVE FOR DATA AND DELIVERY

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BIRMINGHAM 5—T. Ed Kinard, 1013 S. 21st Place, ALpine 2-7912
ARKANSAS
Branch-Merwin Tool Specialists, 477 N. Bellevue, Memphis 5, Tenn., BRoadway 8-6102
CALIFORNIA
OAKLAND 8—The Rucker Co., 4700 San Pablo Ave., OLympic 3-5221
SOUTH GATE—The Rucker Co., 4956 Firestone Blvd., LOrain 4-2521
FLORIDA
MIAMI SPRINGS—Aero Hardware & Supply Inc., 4301 Northwest 36th St., TUxedo 8-2414
GEORGIA
SMYRNA—E. Warren Althouse, 204 Benson Ave., HEmlock 5-0143
ILLINOIS AND IOWA
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(**SOUTHERN ILL.**) Oscar E. Jost Co., P.O. Box 6, St. Ann, Mo., HArrison 8-4488
INDIANA
EVANSVILLE 14—Neff Engineering Co., 2509 Washington Ave., GReenleaf 7-4141
FORT WAYNE 3—Neff Engineering Co., Station A, P.O. Box 2001, 2339 Crescent Ave., EAstbrook 7391
INDIANAPOLIS 2—Neff Engineering Co., 1955 Central Ave., WAlnut 5-5311
SOUTH BEND—Neff Engineering Co., 707 South Eddy St., ATlantic 7-5655
MARYLAND (and Dist. of Columbia)
BALTIMORE 18—N. B. Cochrane Co., 100 E. 20th St., HOpkins 7-4884
MASSACHUSETTS (and New England)
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MICHIGAN
BAY CITY—Fred Kober, 506 So. Chilson St., TWinbrook 2-2629
FLINT 2—Kober Sales Engineering Co., 1115 Root St., CEdar 2-7165
WESTERN MICHIGAN—Everett Adams, 17212 Sharon Road, Chesaning, Michigan, VIctor 5-3446
MINNESOTA
MINNEAPOLIS 8—Air & Hydraulic Equipment Co., 15 E. 38th St., TAylor 3-6118
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(**NORTHERN**) Machinery & Machine Supplies Co., Inc., 305 East 47th St., New York 17, New York, PLaza 8-0744
(**SOUTHERN**) Automation Aides, 1618 Willow Ave., Philadelphia 26, LaMott, Pennsylvania, MElrose 5-5555
NEW YORK
BUFFALO 26—C. H. Tepas Co., 137 Lamarck Drive, CIrcle 3210
NEW YORK 17—Machinery & Machine Supplies Co., Inc., 305 East 47th Street, PLaza 8-0744
OHIO
CINCINNATI 2—Fluid Power Engineering Co., 205 Keith Bldg., MAin 1-6640
CLEVELAND 9 (PARMA)—Fluid Power Engineering Co., 5451 Broadview Rd., FLorida 1-1199
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PORTLAND—The Rucker Co., 1633 N. W. 21st Ave., CApitol 3-0205
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DALLAS 35—Womack Machine Supply Co., 2010 Shea Road, FLeetwood 7-3871
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MILWAUKEE 17—Neff Engineering Co., 5856 No. Pt. Washington Rd., EDgewood 2-1539
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MONTREAL—L. S. Tarshis & Sons, Ltd., 450 McGill St., Quebec, PLateau 2963
TORONTO—Trevor Babbs, National Time & Signal Co., 72 Shilton Rd., Agincourt, Ontario, OXford 1-4857

MECHANICAL AIR CONTROLS, INC.
DETROIT 37, MICHIGAN
MAC

NEW PRODUCTS

EVAPORATIVE HEAT EXCHANGER
. . . gives protection against freezing

Operation: Cools liquid by evaporating a small amount of water on the surface of the tubes carrying the liquid. Liquid temperature is controlled by varying the outdoor air flow across the coils. In below freezing weather the air flow is restricted by a manually operated damper. Casing is made of removable panels to give access to internal parts. Cooling capacities to 18 million BTU per hour.

Niagra Blower Co.
New York, N. Y.

CIRCLE 338 ON TIME-SAVER CARD

AIR MUFFLERS
. . . are corrosion resistant

Features: Not affected by moisture or oil. Tested at pressures over 100 psi. Can be mounted on any valve

discharge port or piping with standard threads, male or female.

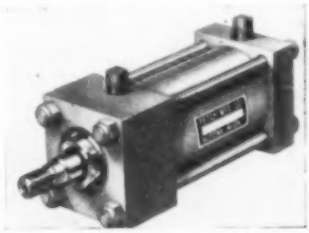
Specifications: Made in $\frac{1}{8}$, $\frac{1}{4}$, $\frac{3}{8}$, and $\frac{1}{2}$ in. pipe sizes. Dimensions of the $\frac{1}{4}$ in. unit are $\frac{7}{8}$ in. dia and $2\frac{1}{2}$ in. long.

The Design Aids Co.
Newark, N. J.

CIRCLE 339 ON TIME-SAVER CARD

CYLINDERS
. . . for air and low pressure hydraulic

Features: Low friction phenolic rod bearing and piston seals. Nonmetallic cushion seal bushings pro-



duce positive reproducible cushion stroke. Large ports give rapid response. Meets all JIC standards and has interchangeable mounting dimensions. Tie rod construction.

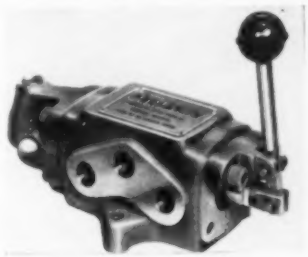
Patch Mfg. Co.
Detroit, Mich.

CIRCLE 200 ON TIME-SAVER CARD

DIRECTIONAL VALVES
. . . for manual or servo control

Designation: 5380 Series

Specifications: May be arranged for solenoid operation and have servo centering and damping. Port



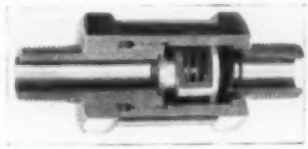
size, $\frac{1}{2}$ in. BSP, maximum pressure 3000 psi, rated flow 10 gpm, maximum servo pressure 2000 psi. Pressure drop through valve 10 to 15 psi. Spool lands may be relieved to give any combination of locking or by-pass control between ports in the valve body.

Keelavite Rotary Pumps & Motors Ltd.
Coventry, England

CIRCLE 201 ON TIME-SAVER CARD

HIGH PRESSURE CHECK VALVE
. . . has resilient seat

Features: Valve has a rubber disc for seating at low pressures. As the



pressure increases, the rubber disc is radially displaced and the poppet rests on a metal seat. Design of seat gives long life to rubber insert.

Specifications: Made in $\frac{1}{4}$ to 4 inch pipe size and $\frac{1}{4}$ to $1\frac{1}{2}$ inch tube size for pressures from 0 to 3000 psi.

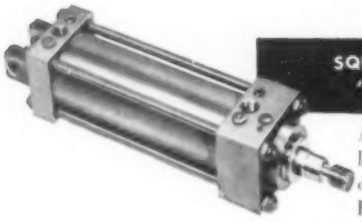
Sealol Corp.
Providence, R. I.

CIRCLE 202 ON TIME-SAVER CARD

Use the TIME-SAVER CARDS for more information.

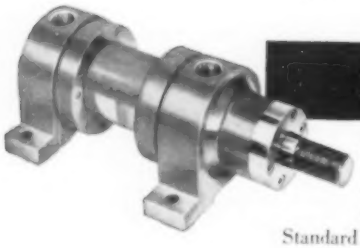
CIRCLE 23 ON TIME-SAVER CARD

for that
BIG PUSH
LINDBERG HAS THE RIGHT CYLINDER



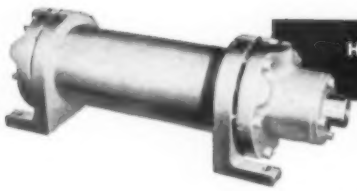
SQUAREHEAD "S" LINE

A feature packed line with the "quick change" feature • Rated 250 psi for air, up to 1000 psi hydraulic • 7 bore sizes thru 6" • Standardized mounting dimensions.
WRITE FOR BULLETIN S-101



2000 PSI "H" LINE

An extra heavy duty hydraulic cylinder • Available with or without cushions • Standard or 2:1 rods • Bore sizes through 8 inches in 5 mounting styles.
WRITE FOR BULLETIN H-101



HEAVY DUTY "A" LINE

A rugged non-tie rod cylinder for air pressures up to 150 psi and low pressure hydraulic service. Bore sizes through 12 inches • Cushions optional • 5 mounting styles.
WRITE FOR BULLETIN A-101

OTHER CYLINDERS
For fast action on mill type cylinders or specials designed to suit your exact needs, send outline of your requirements to our factory.

MEMBER N.F.P.A.

LINDBERG AIR and HYDRAULIC DIV.
TEER, WICKWIRE & CO.
1802 WILDWOOD AVE., JACKSON, MICHIGAN

HYDRAULIC ENGINEERING
FOR INDUSTRY

CARDWELL
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DESIGN SERVICES
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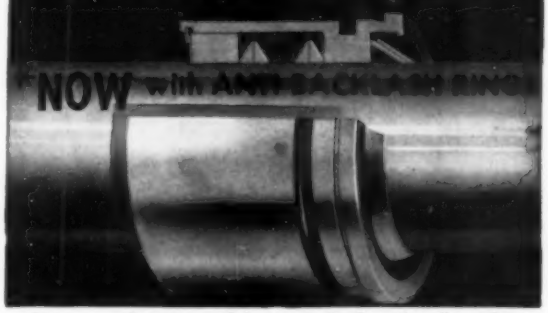
MONOPAK—CARTRIDGE



A complete packing unit for hydraulic or pneumatic rods or cylinders.

- Easily installed or replaced.
- Needs no adjusting.
- Reduces initial machining expense.
- Longer service life.
- Includes "Seal-Guard" rod wiper.
- Low friction coefficient.
- Shock and burst proof.
- Cuts machine down-time.

*Detailed literature on request.

HYDRAULIC ACCESSORIES CO.
24301 Hoover Rd. Van Dyke, Mich.

CIRCLE 130 ON TIME-SAVER CARD

CIRCLE 67 ON TIME-SAVER CARD

USEFUL LITERATURE

STAINLESS STEEL HOSE . . . for 4000 psi and temperatures to 1500 F described in a folder by *Allied Metal Hose Co., Long Island City, N. Y.* Data on flexibility, suggested use and how to determine best lengths. Threaded and flanged fittings are diagrammed.

CIRCLE 412 ON TIME-SAVER CARD

HYDRAULIC CYLINDERS . . . for 3,000 to 5,000 psi are featured in Bulletin 1258 from *The Sheffer Corp., Cincinnati, Ohio.* Cylinders are of the stressed tie-rod design for greater shock load capacity and are made in 2 to 12 in. bores. Ports are SAE straight thread for O-ring sealing.

CIRCLE 413 ON TIME-SAVER CARD

ROTARY PUMPS . . . and fluid motors are described and illustrated in 12-page catalog No. 100, *Tuthill Pump Co., Chicago, Ill.* Complete details on their internal gear, sliding vane, and external spur gear pumps, to 200 gpm and 1500 psi. Pump guide selection charts that classifies operation and construction of all models.

CIRCLE 414 ON TIME-SAVER CARD

FLEXIBLE COUPLINGS . . . made of magnesium to reduce weight 80% over steel, are detailed in a 4-page folder by *Detroit Power Coupling Co., Detroit, Mich.* It covers both the series A, press-on type, and the series B, interchangeable hub design. Made in shaft sizes 3/8 to 6 in.

CIRCLE 415 ON TIME-SAVER CARD

RECIPROCATING CYLINDER . . . that will constantly move in and out at a rate of 10 strokes per min as long as air is supplied to it, is described in a pamphlet by *Lang Pneumatic Ltd., Wolverhampton, England.* The cylinder has a 4-in. bore and strokes of 1/2 to 12 in.

CIRCLE 416 ON TIME-SAVER CARD

LIQUID LEVEL GAGE VALVES . . . for pressures to 4000 psi are presented in 2 data sheets No. 333 and 334 available from *Jerguson Gage & Valve Co., Burlington, Mass.* Valves are union bonnet

Continued on next page

HYDRAULIC SAFETY BULLETIN

IMPROVED FIRE-RESISTANT UCON HYDROLUBES QUICKLY, EASILY INSTALLED IN HYDRAULIC SYSTEMS

Standard flushing and refilling procedures are sufficient for Ucon hydrolube safety hydraulic fluids.

Most hydraulic systems can be quickly and easily converted to fire-resistant Ucon hydrolubes from flammable petroleum oils or synthetic fluids. Actual experience, in hundreds of industrial installations, shows that standard flushing and refilling procedures, involving a minimum of time and effort, are sufficient.

Installation Procedure

The procedure generally followed in converting to Ucon hydrolubes from petroleum hydraulic fluids is:

1. Drain the petroleum oil from the system and remove residual sludge and deposit.
2. Flush the system with Ucon hydrolube.
3. Install a clean filter and replace any worn pump parts and deteriorated gaskets, seals, or packings. Repair leaking pipe joints.
4. Operate at reduced pressure to insure proper lubrication of the hydraulic pump; then, bring the system up to standard operating conditions.

Experience also shows that, once installed, Ucon hydrolubes require a minimum of maintenance because the tendency to creep through pipe fittings and along pump shafts and cylinder rods is often significantly less than with other types of fluids.

FIRST FEW WEEKS IMPORTANT

During the first few weeks of operation, filters and inlet screens may sometimes become clogged by sludge and other unwanted deposits loosened by the solvent action of the hydrolube. Since stoppage may cause pump starvation and cavitation, noisy operation, and high pump wear, filter cartridges should be replaced and inlet screens cleaned as often as needed.

When replacing non-aqueous, fire-resistant fluids with Ucon hydrolubes care should be taken to remove all of the previous fluid from the hydraulic system. This can best be done by draining the non-aqueous fluid from the system, flushing with a petroleum hydraulic oil and then following the installation procedure previously outlined.

FIRE-RESISTANCE PROVED BY TESTS

The common fire hazards connected with hydraulic operations are eliminated when Ucon hydrolubes are used. This has been proved by tests and more than 10 years of routine use in industrial hydraulic equipment. Ucon hydrolubes are approved by Factory Mutual Laboratories.

Get all the facts on Ucon hydrolubes. Write for the booklet, "Ucon Hydrolubes Spell Safety." Address . . . Department B.

UNION CARBIDE CHEMICALS COMPANY

DIVISION OF UNION CARBIDE CORPORATION

30 E. 42nd Street, New York 17, New York

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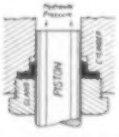
CIRCLE 136 ON TIME-SAVER CARD

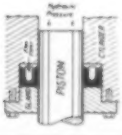
Page...

a dependable source for mechanical packings

Cup packing



Flange packing



"U" packing

"V" packing

Available with permanent type impregnants for temperatures to 225° F.

When you have exacting specifications to meet . . . plus a budget to watch . . . it will pay you to check with Page. You'll get the right packings fast . . . including packings with permanent type impregnants for temperatures from —65° F. to 225° F. . . . and benefit from the engineering know-how and complete facilities of an organization with nearly a century of experience.

You'll find a complete line of U's, V's, Cups and Flanges, made from various leathers with special impregnations to meet a wide range of applications. Standard synthetic packings also available.

Specify Page Packings. You'll get complete cooperation and a dependable source of supply. Write for your copy of the Page Packing Manual.

PAGE BELTING CO. trademark

PAGE BELTING COMPANY

established 1868

Concord — New Hampshire

Page Packings — engineered to do a better job

USEFUL LITERATURE

type with union connections to the gage. Complete installation and ordering information.

CIRCLE 417 ON TIME-SAVER CARD

CONTROLS . . . for pressure and vacuum. Catalog 500 available from *United Electric Controls Co., Watertown, Mass.* Contains over 190 standard types and models classified for easy finding and reading. Specifications are arranged in charts for quick identification of model numbers.

CIRCLE 418 ON TIME-SAVER CARD

GEAR PUMPS . . . flow control valves, motors and cylinders are illustrated in a 4-page brochure from *Keelavite Rotary Pumps & Motors Ltd., Coventry, England.* The 26 photographs give a picture of the company's versatility in the fluid power field.

CIRCLE 419 ON TIME-SAVER CARD

MINIATURE CYLINDERS . . . for air or hydraulic service at pressures to 2000 psi are presented in data sheet No. 458A from *Control Line Equipment, Cleveland, Ohio.* Included is a chart telling the force obtained from the ¾, 1, and 1⅛ in. bore cylinders at various pressures.

CIRCLE 420 ON TIME-SAVER CARD

FLEXIBLE COUPLINGS . . . of continuous sleeve design. A 4-page brochure by the *Mechanical Power Transmission Div. of Zurn Industries, Inc., Erie, Pa.* Design and application data on new Amerigear Series GC flexible couplings. Explains how combinations of positive hub seals and the 1-piece sleeve design saves money and reduces maintenance.

CIRCLE 421 ON TIME-SAVER CARD

MOLDED PACKINGS . . . for pneumatic and hydraulic equipment are covered in a 12-page catalog by *Johns-Manville, New York, N. Y.* It recommends material and illustrates cross sections of their U-cups, A-cups, and hat cups. Also facts about special packings and application.

CIRCLE 422 ON TIME-SAVER CARD

CIRCLE 134 ON TIME-SAVER CARD

PAT. PENDING

TRU-SEAL

Saves hours in piping installations

Eliminates leaks in oil, air, water, vacuum, chemical lines

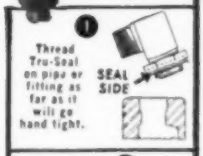
Tru-Seal saves hours in assembling piping installations because it enables you to run your pipe lines in any direction you wish, quickly and easily—without having to recut and re-thread piping sections. Wherever used on air, oil, water, steam, vacuum or chemical lines, it seals perfectly at —100° F. to plus 500° F.—*without the use of pipe dope.* Its installation requires only light tightening torque, thus eliminating over-tightening damage to valves, pumps, compressors, and other fittings.

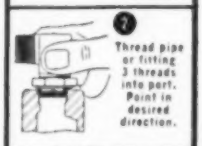
For further information write

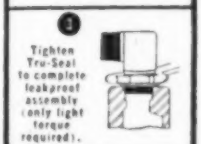
TRU-SEAL DIVISION
FLICK REEDY CORPORATION

2008 N. Hawthorne, Melrose Park, Ill.

"Miller Fluid Power" is also a Div. of Flick-Reedy Corp.







CIRCLE 45 ON TIME-SAVER CARD

AUTOMATING?

Keep It Simple

with the ELECTRO-SNAP

One-Way Impulse

PRECISION LIMIT SWITCH

Type ES4-KM2 shown

Before finalizing design on your automatic tools or systems, get full details on the ELECTRO-SNAP ES4 family of switches. Many variations available . . . all trouble-savers!

- Fewer switches needed.
- Simpler, cheaper than timers.
- More reliable than fancy circuitry capable of same job.

WRITE FOR DATA SHEET ESF-1

ELECTRO-SNAP CORPORATION

4224 West Lake Street
Chicago 24, Illinois

ELECTRO SNAP

NEW

SINGLE OR 2-SPOOL VALVE

MODEL WP

PARALLEL VALVE

for heavy duty industrial mobile hydraulic applications

GRESEN HYDRAULICS

Capacity: **40 GPM** at 20 ft./sec.

MAX. PRESSURE: 1500 PSI

Features:

SPOOLS – fully balanced, self centering, accurately feathered for fine metering action – separate ball checks for each spool.

CARTRIDGE type relief valve has hardened seat.

TRIPOD mounting feet for easy installation.

CHOICE of many modifications.

WRITE FOR LITERATURE

GRESEN *Mfg. Co.*

405 35th Ave. N.E., Minneapolis 8, Minn.

CIRCLE 58 ON TIME-SAVER CARD

WORLD'S LARGEST ON-THE-SHELF STOCK OF HYDRAULICS

NEW PALLEY HYDRAULIC CYLINDERS – Here are two of our newly developed lines of Industrial Hydraulic Cylinders. These cylinders are designed to meet the most rigid requirements of industry. All are double action with rugged steel construction. Type (A) is a heavy duty, external cap type cylinder which ranges up to a thrust of 37,500 lbs. Type (B) is flange mounted, Press type which delivers up to 21,000 lbs. thrust at 3000 PSI. For complete listing of our prices and our tremendous stocks send for Catalog below!

A AS LOW AS 56.45

B 36.00 AND UP

4-WAY – SLIDING PISTON HYDRAULIC VALVE A newly developed hydraulic valve which can be connected in series to operate two or more cylinders, in unison or independently. Has a built-in relief valve, adjustable up to 3000 PSI. Maximum flow of 10 GPM. 2000 PSI type at $24.50 or 3000 PSI type at $32.75

ELECTRIC HYDRAULIC PUMP MOTORS AS LOW AS 99.50

Designed to direct-couple to aircraft type hydraulic pumps. For continuous duty with high starting torque. 115/230 V, 220/440V, 1 and 3 phase, 60 cycle AC. Sizes from 3/4 to 15 HP. Complete details in Catalog below.

GOV'T SURPLUS BUYS

VICKERS HYDRAULIC ANGLE PUMPS

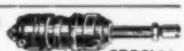
Cat. No.	GPM	PSI	RPM	Price
H-P4A	5.3	1000	3000	$22.50*
H-P5A	2.7	1500	3000	25.75*
H-P4U	6	1000	3000	22.50*

*Used but excellent condition.

SPECIAL CATALOG

396 PAGES Shows the largest stock of Hydraulic Equip. and Supplies ever stocked under one roof. Plus elect. motors, pumps, tools, etc. Send for your copy Today and SAVE!

2000 PSI HYDRAULIC CYLINDER SPECIAL Only 12.75



Genuine top quality Gov't Surplus. Used but excellent condition. Has a Bore of 2-1/4", Shaft 1", Stroke 4". Eye-to-eye lgth. 13½". Ports 1/4" AN.

Palley's

ORDER TODAY – Pay by Money Order or Check. ½ deposit with C.O.D.'s. All prices F.O.B. Los Angeles.

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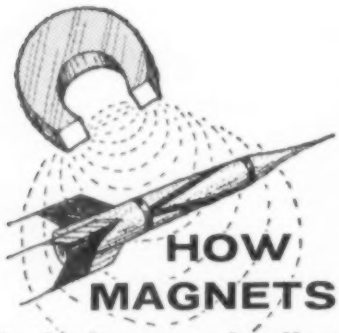
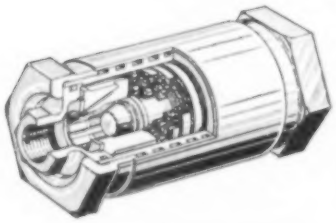
CIRCLE 102 ON TIME-SAVER CARD



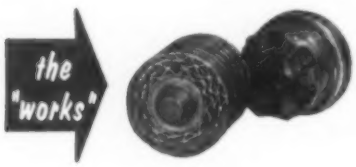
HOW MAGNETS help keep missiles and aircraft flying



FERRO FILTER

Magnetic Separators

protect fluid power systems of missiles and aircraft by removing even microscopic ferrous particles that can jam delicate, precision made hydraulic equipment. Shown above, Model PX-2; dry weight only 3 lbs; 3000 psi working pressure; tapped for ½" tube connection-AND-10050.



Liquid flows through stack of steel grids (left) magnetized by two powerful Alnico permanent magnets (one shown, right). The "honeycomb" design splits the fluid stream, and fine ferrous particles are caught on the grid edges.

Send for Bulletin 65-A

High pressure industrial FERROFILTER models are also available.

S. G. FRANTZ CO., Inc.

Brunswick Pike & Kline Ave.
P. O. Box 1138 Trenton 6, N. J.

CIRCLE 51 ON TIME-SAVER CARD

POST SCRIPTS OF INDUSTRY

News about people, manufacturers and sales organizations

Paul P. Huffard, a director of the Union Carbide Corp., has been elected to the board of directors of **Greer Hydraulics, Inc.,** Jamaica, New York.

Paul P. Huffard Greer Hydraulics

Russell E. Schulke E. D. Sweetland Co.

Hanna Engineering Works has appointed **E. D. Sweetland Co.,** 1250 First Avenue South, as its exclusive representative in the Seattle, Washington, area. **Russell E. Schulke** is in charge of this operation.

J. B. Sewell was appointed president of **The Garlock Packing Co. of Canada, Ltd.** Announcement was made by George L. Abbott, chairman of the board of directors of the parent firm, The Garlock Packing Co. of Palmyra, N. Y.

Flow Products Inc., Chicago, Ill., was made distributor for the **W. S. Shamban Co.,** Culver City, Calif.

Consolidated Diesel Electric Corp., Stamford, Conn., has appointed **John A. Grimes** general manager, test equipment div. Grimes has been with Con Diesel for the past three years as administrative engineer and assistant to the president.

Taylor-Westerfield, Inc., has been named sales representative for **Galland-Henning Nopak Div.** to cover the Youngstown, Ohio area. William Taylor and John Westerfield head this sales organization.

Vickers, Inc., Detroit, Mich., announced these appointments: **Gregory M. McKeown** to the newly created position of branch operations manager, Machinery Hydraulics Division. He will primarily be concerned with integrating the activities of all branch warehouse and custom built power unit operations in Seattle, Wash., El Segundo, Calif., Chicago, Ill., Springfield, N. J. and

G. M. McKeown Vickers, Inc.

Archie Laird Vickers, Inc.

W. S. Bobier Vickers, Inc.

with development and planning of similar branches. **Archie Laird** to manager of the Atlanta office. **W. S. Bobier** to chief engineer, Detroit Activity of the Aero Hydraulics Division.

Continued on page 158

it gives—
and it takes
the higher the pressure—
the better the seal
NOTHING
GETS PAST
Hallprene
Hallprene
the seals that pressure can't lick
FOR FULL DETAILS WRITE TO
HALL & HALL LTD
OLDFIELD WORKS HAMPTON MIDDLESEX ENGLAND
Tel: Molesey 2180 (8 lines)
PATENT
P4309

POST SCRIPTS OF INDUSTRY

Flexonics Corp., Maywood, Ill., named **Eugene Ransom** general manager of the Industrial Hose Division. Ransom was previously on special assignment at the company's Memphis, Tennessee, plant. **James R. Strother** was appointed sales manager of the Industrial Hose Division. **John F. Fisher** is division factory manager, **L. B. Donkle** is division engineering manager and **J. A. Downey** production manager.

William P. Munger has been elected president of **Hydel, Inc.**, Cambridge, Mass., a research and development firm specializing in hydraulics, pneumatics, electronics, and computers. Munger also is director of mechanical research for American Brake Shoe Co.

Babcock & Wilcox Co., Tubular Products Div., Beaver Falls, Pa. has promoted three men in their sales department. **G. H. Weight** is sales manager, middle states with headquarters in Chicago. **J. H. Roach**, of the Houston office, is named manager of the Tulsa office. **W. C. Mohrman**, of the Tulsa office, becomes district sales manager of the Houston office.

Commercial Shearing and Stamping Co., Youngstown, Ohio opened a new sales office in East Orange, N. J. to cover the eastern and middle-atlantic states. **Melvin E. Stewart** will head the office. He has been in Commercial's sales department for the past 10 years.

C. A. Norgren Co., Englewood, Col., has reorganized their engineering department. **Andrew Zmuda** was appointed chief engineer. He has had many years experience in research with General Motors and the DeVilbiss Co. **Morley V. Freidell** who has been in Norgren engineering 4 years was made supervisor of a newly created Research and Development section. To head its laboratory work, **Ralph C. Baker** was given the post of engineering laboratory supervisor. He has been in development work for the past eight years. **Kirk Carlsten**, who has been with Norgren two years, is now product design and drafting supervisor.

Andrew Zmuda C. A. Norgen Co. *Morley V. Freidell C. A. Norgen Co.*

Capital

HYDRAULIC OIL FILTER with Monel Metal Insert

Reservoir Type for Hydraulic and Oil Re-circulating Machinery

EASY TO INSTALL—EASY TO CLEAN
LONG LIFE—LOW COST—SIZES AND SCREENS TO FIT YOUR NEEDS

★ ONLY THREE PARTS
★ MEETS J.I.C. STANDARDS
★ GREATER FILTERING AREA
★ SPECIAL TRAP-WEAVE MESH

Specially woven MONEL wire cloth and a new method of compact corrugation, gives triple protection with less space than other filters of like capacity. Trap-weave mesh stops thin, elongated particles with NO loss of efficiency.

Non-corrosive, non-toxic materials throughout. Easily cleaned with an ordinary brush.

Write for descriptive circular.

CAPITAL ENGINEERING & MFG. CORP.

5836 SOUTH ASHLAND AVENUE, CHICAGO 36, ILLINOIS

John Tullis was elected executive vice-president of **Stratoflex, Inc.,** Fort Worth, Texas. Tullis had formerly been executive vice-president of Unit Rig & Equipment Co. in Tulsa.

John Tullis
Stratoflex, Inc.

C. H. May
Briggs Filtration Co.

Clifford H. May was named director of research and development for **The Briggs Filtration Co.,** Washington, D. C. May was formerly project engineer at U. S. Engineer Corps, Fort Belvoir, Va.

Parker-Hannifin Corp. has made the following appointments: The Parker Seal Div. has named **James S. Bogart III** as representative to cover the Pacific Northwest States, and **J. W. Swan** for the Chicago area. **Depatie Fluid Power Co.,** Kalamazoo, Mich., was named distributor for the seal division. New distributors for the Parker Fittings and Hose Div. are; **J. M. Tull Metal and Supply Co.,** Birmingham Ala.; **Gordon Auto Parts Co.,** Moundsville, W. Va.; **Williams and Co.** of Cleveland and Toledo, Ohio; and **Palmer Supply Co.,** Seattle Wash., as a distributor for Parker piston-type accumulators.

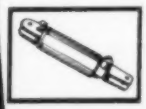
John M. Sayre, formerly with Solar Aircraft Co., has joined **Resistoflex Corp.,** Roseland, N. J. as manager of advertising and public relations.

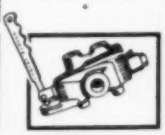
Kenneth T. Bjertnes has been elected vice-president and director of the recently organized **Fluid Dynamics Div. of Gerbing Mfg. Corp.,** Northbrook, Ill.

Continued on next page

CIRCLE 59 ON TIME-SAVER CARD

Free BIG CATALOG
NEW AND GOV'T. SURPLUS BARGAINS





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CYLINDERS
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VACUUM PUMPS
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Send NOW for this FREE Illustrated Catalog of Top Quality Items at Bargain Prices
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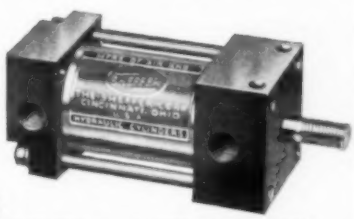
IMPROVED...NEW
UNIVERSAL, CLEVIS or PIVOT MOUNT
1-1/8" CLAMP TYPE AIR CYLINDERS!

CLA SERIES
Double Acting and Spring Return



INEXPENSIVE
ANSWER to TOOLING and AUTOMATION!

- COMPACT—only 1½ inches square.
- VERY SHORT overall length.
- MOUNTS front or rear flange, side, clevis or pivot.
- TIE ROD construction.
- HEADS machined from aluminum bar stock. Tubes, mirror smooth brass.
- PISTON ROD—high tensile steel, chrome plated.
- 150 psi AIR; 400 psi hydraulic
- ADEQUATE safety factor.
- IMMEDIATE delivery on 1", 2" and 3" stroke. Fractional or longer strokes available on short notice.

Write NOW for NEW Bulletin No. 458
SHEFFER
THE SHEFFER CORPORATION
Cincinnati 15, Ohio • Phone: VAlley 1-0320
Manufacturers of the industry's most complete line of air and hydraulic cylinders
SOLD BY LEADING DISTRIBUTORS NATIONWIDE

CIRCLE 121 ON TIME-SAVER CARD

UP TO 3.5:1 MECHANICAL ADVANTAGE AUTOMATICALLY!
DOUBLE ACTING
Toggle Linkage Hand Pumps
Just select the proper portion of the stroke
Models for 1000, 3000, and 10,000 P.S.I.
Hydraulic pumps, needle valves, 4 and 5 way valves, electric pumps, hydraulic wheels.
Write Dept. AP-9
MECHANISMS CO.
118 E. 2nd St. • Uhrichsville, Ohio

CIRCLE 91 ON TIME-SAVER CARD

Phil:
Our present piston cups are unpredictable-
some hold up well enough, others go to pieces
(extruding, usually) in a hurry. How come?
Hal

MEMO

Hal—
Probably sloppy molding.
R/M piston cups are precision molded
... you can count on them for consistent
top-quality performance, exact fit.
Phil

You can see the extra quality, the extra performance you get from R/M Piston Cups under close examination. The clearly defined, accurate contours, the cleanly trimmed edges, the thorough penetration of compound through the fabric, all these are signs of a careful, reliable molding job. The results for you are resistance to ply delamination, longer service life, and precision fit.

Your needs are sure to be met by one of the seven R/M styles: Neoprene and duck or Buna-N and duck in three hardnesses—or Buna-N and asbestos.

Feel free to call on the R/M packing engineers for specific recommendations. They have amassed a wealth of experience in meeting the most exacting requirements of industry. Get in touch with R/M!

R/M's complete line of mechanical packings includes Vee-Flex® and Vee-Square® Packings, Homogeneous V-Rings, and Fabric Piston Cups. Write for complete information.

R/M PACKINGS
RAYBESTOS-MANHATTAN, INC.
PACKING DIVISION, PASSAIC, N.J.
MECHANICAL PACKINGS AND GASKET MATERIALS

RAYBESTOS-MANHATTAN, INC., Mechanical Packings • Asbestos Textiles • Industrial Rubber • Engineered Plastics
Sintered Metal Products • Abrasive and Diamond Wheels • Rubber Covered Equipment • Brake Linings
Brake Blocks • Clutch Facings • Industrial Adhesives • Laundry Pads and Covers • Bowling Balls

POST SCRIPTS OF INDUSTRY

Minnesota Rubber Co., Minneapolis, Minn. has named **Richard K. Mattocks** sales manager. He has been with Minnesota since 1956. Prior to that Mattocks had been with Illinois Bell for 15 years.

R. K. Mattocks
Minnesota Rubber Co.

Thomas M. Kirshner has been appointed district manager for the **Boston Woven Hose & Rubber Co.,** Boston, Mass.

Robert W. Bowman has been promoted to vice president in charge of organization planning at **Aeroquip Corp.,** Jackson, Mich. Bowman was formerly chief industrial engineer of the corporation. **Fred W. Schwier** was named general sales manager of the Jackson Division. Schwier had been Aeroquip's assistant aircraft sales manager.

F. W. Schwier
Aeroquip Corp.

Stanley M. Proctor
S. M. Proctor Co.

Rivett Inc., Boston, Mass., has appointed **Stanley M. Proctor Company,** Cleveland, Ohio, as distributor in Northern Ohio for their air and hydraulic valves and cylinders. Proctor has had many years in air and hydraulic sales and handles a number of associated lines.

CIRCLE 156 ON TIME-SAVER CARD

For long-lived high performance, get

GAST ROTARY VANE AIR PUMPS

Here's the broad Gast Line of Air Compressors. Vacuum Pumps, too, are made in all these models. Capacities from .6 to 45 cfm., pressures to 30 psi., vacuum to 28" Hg. Rotary-vane design is simple, efficient, dependable. Positive, pulseless air delivery—no tank needed. For plant use or O.E.M., *get Gast quality!*

Write for Gast Catalog; describe your specific needs.

GAST MANUFACTURING CORP., P.O. Box 117-D
Benton Harbor, Michigan

See Catalog in Sweet's Design File

GAST ROTARY

- AIR MOTORS TO 7 H.P.
- COMPRESSORS TO 30 P.S.I.
- VACUUM PUMPS TO 28 IN.

"Air may be your answer!"

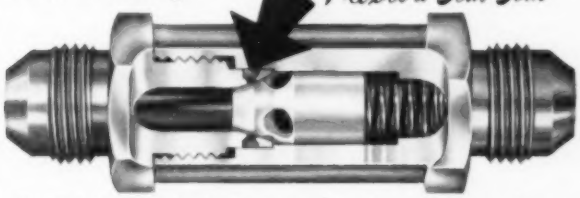
CIRCLE 76 ON TIME-SAVER CARD

OPERATIONAL ACCEPTANCE

Kep-O-seal Check Valves

. . . on Rockets and Missiles

Positive Acting *Flexible Seal Seat*



Kep-O-Seal Check Valves have operational acceptance and are standard equipment for major liquid propellant rocket engines. Space-tested and approved for fuel control, hydraulic and pneumatic systems, both for ground support and airborne. Engineered to take terrific shock and retain leak-tightness.

Excellent performance, low pressure drop and rugged construction for installations demanding critical leakage control.

Patent Applied for. Write for Catalog!

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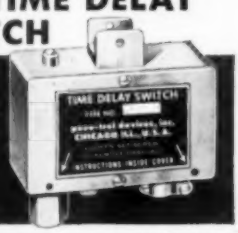
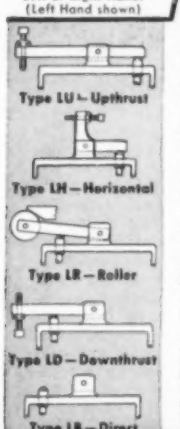
7365 West 59th Street • Summit, Illinois

Pneu-Trol TIME DELAY CONTROL SWITCH

. . . Gives Cylinder Applications Greater Efficiency Accuracy . . . Wider Use!

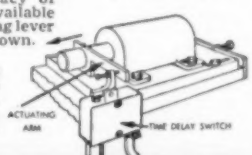


For any type actuation Left or Right Hand. (Left Hand shown)



- **Holds Cylinder dwell accurately to fraction of second.**
- **Automatically re-sets.**
- **Simple, Compact, Rugged.**

You can hold any motion or operation controlled or actuated by air or hydraulic cylinders at a positive stop on either end of the stroke for ¼ to 60 seconds in 20 to 1 ratios with Pneu-Trol Time Delay Control Switches. Simple in design with positive hydraulic timing action . . . compact and easily mounted on the machine or fixture, Pneu-Trol Switches are providing millions of trouble-free actuations in solenoid-operated cylinder applications of every type. Positive, controlled time dwell permits wider use of air or hydraulic power in automatic operations, increases accuracy of work by insuring split-second accuracy of the dwell. Available with 5 actuating lever linkages as shown.



Switch mounted to provide dwell at end of power stroke of single action, spring return cylinder.

Pneu-Trol DEVICES, INC.
1414 N. KEATING AVENUE • CHICAGO 51, ILL.

CIRCLE 108 ON TIME-SAVER CARD

MARSHALLTOWN

THE RIGHT GAUGE FOR YOUR SPECIFIC NEEDS

Available in a wide variety of general purpose and special purpose gauges in pressure ranges to meet your specifications in every particular.

- PRESSURE
- VACUUM
- COMPOUND
- ALTITUDE
- COMBINATION
- DIAPHRAGM
- HYDRAULIC
- AND SPECIAL PURPOSE GAUGES
- DIAL THERMOMETERS (Vapor Tension or Bi-Metal)

WRITE TODAY FOR COMPLETE INFORMATION

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CIRCLE 87 ON TIME-SAVER CARD

for every requirement

STRATOFLEX

HOSE & FITTINGS

• Fuel Lines • Hydraulic Systems
• LP-Gas Lines • Air Brakes
• Lubrication Systems • Water
• Coolants • Refrigerants

Made in a wide variety of sizes and types for hundreds of commercial and industrial uses, Stratoflex detachable and reusable fittings simplify maintenance and assure leak-proof connections under extreme temperature variations. Stratoflex hose provides the flexibility, small bend radii and durability essential for dependable service.

For detailed information, write for industrial catalog.

SF7-8

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MARKET PLACE

WANTED

Experienced sales engineer to sell pneumatic and hydraulic equipment for well established firm in central and western Michigan. Salary and commission. All replies confidential. Write to Box 9158, APPLIED HYDRAULICS & PNEUMATICS.

EASTERN SALES—ENGINEER REPRESENTATIVE

This West Coast organization is seeking a sales engineer to sell nationally accepted hydraulic line to aircraft and missile industry. Must have proven ability to sell technical products. Engineering background, aircraft experience or familiarity with hydraulics desirable but not mandatory. Give complete resume and salary expected with first letter. Write to Box 9258, APPLIED HYDRAULICS & PNEUMATICS.

MANUFACTURERS EXCLUSIVE REPRESENTATIVE WANTED

Leading manufacturer of hydraulic equipment, nationally advertised, wants man to operate direct with home office on salary and commission to cover New England territory. Should be centrally located in Massachusetts. Only first class party with wide knowledge of hydraulics will be considered. Mail snap-shot photo and complete details of background. Later contact will be made by company officer. All replies held in strict confidence. Write to Box 9358, APPLIED HYDRAULICS & PNEUMATICS.

MANUFACTURERS EXCLUSIVE REPRESENTATIVE WANTED

Leading manufacturer of hydraulic equipment, nationally advertised, wants man to operate direct with home office on drawing account and commission. One to operate from Seattle and one in San Francisco. Only first class parties will be considered. Mail snap-shot photo and complete details of background. Later contact will be made by an officer of company. All replies held in strict confidence. Write to Box 9458, APPLIED HYDRAULICS & PNEUMATICS.

WANTED HYDRAULIC SALES ENGINEER

The Cardwell Machine Company, Richmond, Virginia, one of the major engineering and fabricating organizations in the South for hydraulic power units, hydraulic machinery, panels and consoles, requires young man for sales engineering job. Hydraulic background, not necessarily academic, sales correspondence experience, schematic circuit design are essential. Applicant will live in Richmond. This is a permanent position with good starting salary and excellent future in a company established for 129 years. Profit sharing, vacation, free life insurance and many other benefits. Write in confidence to Henry S. Holland III, Executive Vice President, The Cardwell Machine Company, P. O. Box 1359, Richmond 11, Virginia.

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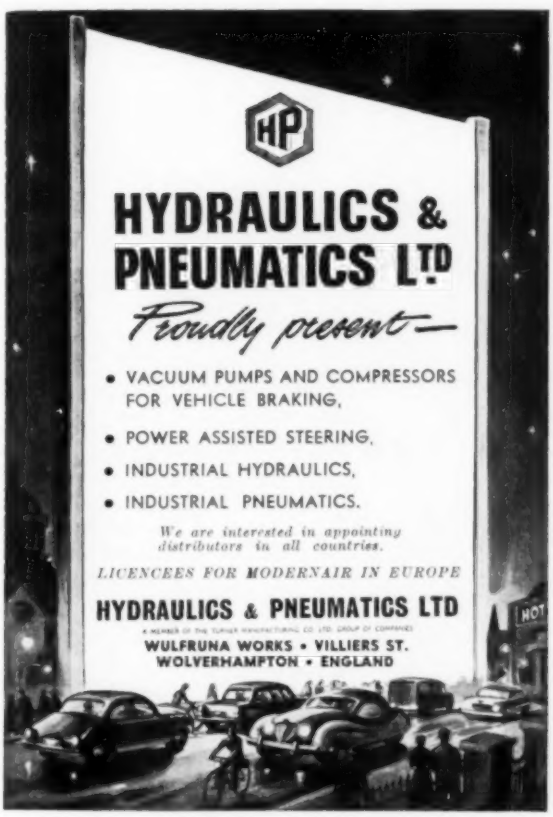

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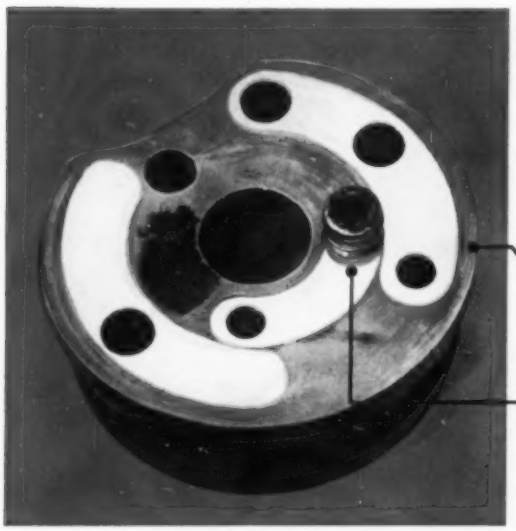

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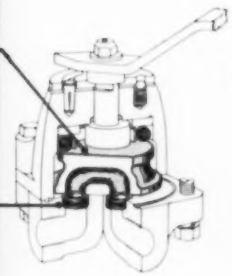

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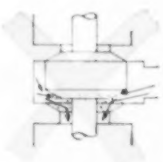

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